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THE ROYAL ENGINEERS JOURNAL.

Vol. XXXII. No. 1. JULY, 1920.

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THE R.E. WAR MEMORIAL SCHOLARSHIPS.

THESE scholarships, at present reserved for the children of R.E. officers and other ranks who were killed, died of wounds or disease contracted on active service, or permanently disabled in the Great War, are of two values, £40 and £15 per annum respectively, and a Committee named the R.E. War Benefits Committee has been appointed by the R.E. War Memorial Committee to carry out the awards. Its constitution is as follows :—

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BRIG.-GENERAL R. H. H. BOYS, C.B., D.S.O., *A.A.G., R.E.*

Members.

Representing R.E. CHARITABLE FUND.—BRIG.-GENERAL G. WALKER, D.S.O., *Chief Engineer, London District.*

Representing TERRITORIAL FORCES.—LIEUT.-COLONEL R. H. JOSEPH, D.S.O., *R.E., T.F.*

Representing R.E.O.C.A.—REGTL. Q.M.S. J. WALSHAW, R.E., and Mr. W. W. CHAMPNESS.

Secretary.

COLONEL F. E. G. SKEY, *Secretary, R.E. Institute.*

This Committee commenced its duties on the 28th April by drafting a notice and a form of application, the former of which has been circulated to all readers of *The R.E. Journal*, to all C.E.'s and C.R.E.'s, to the Secretaries of Territorial Associations, to the Presidents of many Scientific Institutions, to the Headquarters of the National Federation of Discharged Soldiers and Sailors, and of the Comrades of the Great War, and the R.E.O.C.A., many of whom have generously promised to advertise the scholarships widely among their members.

Owing to the generosity of the publishers, and through the influence of Mr. Champness, the scholarships have had a very wide free advertisement in all the principal newspapers. Over 600 letters have already been received by the Secretary, and a large number of applications have come in, some of which are being adjudicated upon and others have been placed on record until the candidates shall arrive at the ages laid down in the notice. It is hoped that by next month the first list of R.E. War Memorial Scholars will be available for publication.

In spite of the large number of applications already received, the Committee feels that news of the scholarships has not yet reached all possible applicants. This is especially felt to be the case of the children of deceased officers, and the Committee begs all those who read this notice to do their best to make the scholarships more generally known.

Further subscriptions to the R.E. WAR MEMORIAL will be gratefully received by COL. F. E. G. SKEY, SECRETARY, R.E. WAR MEMORIAL, R.E. INSTITUTE, CHATHAM.

*LIFE OF LORD KITCHENER. BY SIR GEORGE ARTHUR.**

By COLONEL E. M. LLOYD, LATE R.E.

SIR George Arthur has undertaken a difficult task, and has done it remarkably well. The forty-five years of Kitchener's service as a soldier were so full of incident, he was so largely engaged in the solution of intricate problems of various kinds, that his biographer has to make room for a bewildering mass of detail, and the personality of the man runs risk of being swamped by the record of his deeds. Also the last phase of his life, his part in the Great War, overshadows everything else and makes it no easy matter to preserve true perspective. But Sir George has steered his course safely between these rocks and shoals. He has the advantage of intimate friendship, and has succeeded in giving a clear, well-proportioned account of Kitchener's work and a life-like portrait of the man.

He was born on Midsummer Day, 1850. He was of Suffolk stock, though he happened to be born in Ireland. He was educated at home except for two years' schooling in France and Switzerland, and a year and a half with the well-known crammer, Frost. His father wished him to join the cavalry, but he was bent on becoming an officer of Royal Engineers. As a cadet at Woolwich he was not remarkable. He was a lanky youth, rather backward though a hard worker; but he had a knowledge of French and German, and was a good rider. He did not care for games and made few friends. He obtained his commission on the 4th January, 1871, being last but one of his batch. At the end of that month he made an attempt to see active service under Chanzy; but the fighting was over by that time, and exposure at Laval brought on an attack of pneumonia, from which he was slow to recover.

Among his few friends at Woolwich was Claude R. Conder, who was put in charge of the Survey of Western Palestine in 1872. By his invitation Kitchener joined him two years afterwards, and was engaged on this work for the next four years, being latterly in charge of the Survey. It was a task of danger as well as difficulty, and his health as well as Conder's suffered under the strain. When the map was finished the Committee of the Exploration Fund recorded their thanks to him, not only for the skill and devotion displayed, but for having kept his expenses below the estimate. In the autumn

* 3 Vols. (Macmillan). Price £2 12s. 6d.

of 1878 he was charged with the Survey of Cyprus, and here he showed independence of character. He proposed to start with a triangulation, but the High Commissioner, Sir Garnet Wolseley, would not have it. The map was to be made of village surveys pieced together. The R.E. subaltern appealed to the Foreign Office, and the triangulation was approved; but the execution of the survey was suspended as long as Wolseley remained in Cyprus.

At the beginning of 1883 Kitchener went to Egypt as second-in-command of the cavalry of the new army which Sir Evelyn Wood was raising. Up to this time his health had not been good, but the climate of Egypt worked a transformation; food and sleep became matters of indifference to him, and his physique responded to the severest calls upon it. In 1884 Sir Samuel Baker wrote of him to Gordon as "one of the *few very superior* British officers, with a cool and good head and a hard constitution, combined with untiring energy." Kitchener's report on the Sudan when he was sent up the Nile to Debbeh in April, 1885, goes to justify Baker's opinion of him. His work in Egypt during the next twelve years made a similar impression on Lord Cromer and Lord Salisbury, so that the latter insisted that he should not be superseded in the command of the Expedition for the recovery of Khartoum. There seemed some likelihood that a senior officer might be appointed on account of the large number of British troops employed in the last stage.

The admirable organization of the Expedition and the skill with which it was carried out raised his reputation greatly, the more so because of the general eagerness to see the slur of 1885 wiped away. The tact which he showed at Fashoda, and the breadth of view with which he dealt with Soudanese problems threw fresh light on his capacity.

It was Lord Salisbury who decided, when Lord Roberts was sent to South Africa, that Kitchener should accompany him as Chief of the Staff. His functions hardly corresponded to his title. He was rather a sort of second-in-command, given special tasks to execute, and detached from time to time to act as Roberts' representative. Eight years before, Roberts had expressed the opinion that a Chief of Staff in the German sense was not well suited to British conditions:—"I doubt whether any really competent general or commander-in-chief would contentedly acquiesce in the dissociation of command and responsibility which the German procedure necessarily entails." Friction, he thought, would be almost sure to arise "unless the commander-in-chief were one of those easy-going soft natures which ought never to be placed in such a high position."* The part played by Berthier under Napoleon was, of course, very different, but would not have suited

* *The Brain of an Army*, by Spenser Wilkinson, second edition, pp. 13-15.

Kitchener or turned his energy to account. As it was, the happiest relations prevailed between the two men. After taking over the command in December, 1900, Kitchener wrote to Brodrick:—"We have never had, during the most anxious and difficult times, a single moment of unpleasantness," and Roberts told the Queen on his return to England "of Kitchener's self-suppression, his eagerness to undertake the hardest and most difficult tasks, his scorn of notoriety, and his personal loyalty."

Paardeberg was the most important instance in which Kitchener acted as Roberts' representative, and the result was disappointing. Sir George Arthur attributes this to the want of an adequate staff, and blames Roberts for having "omitted to provide his deputy with the means of exercising the authority which he delegated." But in his own version of the fight, written three years afterwards in India, Kitchener makes no reference to this deficiency; he maintains that he took the right course and accepts full responsibility. Like everyone else, he had to learn by experience how to fight Boers.

A slight tendency to the disparagement of Roberts is noticeable elsewhere in these volumes, and exaggerated stress is laid on the mischief done by Roberts' saying that the war was practically over when he handed over the command. It showed a want of foresight, but guerrilla warfare defies prediction. Two months afterwards Kitchener, after his meeting with Botha, was sanguine that peace was within reach. A year and a half was needed to bring it about,—and it was attained then by Kitchener's boldness of conception in the use of barbed wire, blockhouses and drives, and by his skill and patience in negotiation. He was fortunate in having the hearty support of Mr. Brodrick, the War Minister, and he reaped further advantage from their cordial relations when he was commanding in India and Mr. Brodrick was at the India Office.

Kitchener's seven years in India were in their way as strenuous as the seven preceding years in Africa. In the reorganization of the army with a view to war, the improvement of the condition of the soldier, and the abolition of the dual control he had to encounter strong opposition. On the principle of *divide et impera*, as we are told, the Viceroy fought hard for the Military Member of Council. The present Lord Salisbury, in his interesting preface, says that Kitchener "had no skill in argument, and no respect for it." That may be so as regards the mere thrust and parry of verbal fence. But he could hardly have carried his reforms if he had been without skill in the statement of his case. Those who disapprove of the changes he brought about practically pay a high tribute to his powers of persuasion.

At the end of 1905 Lord Minto succeeded Lord Curzon as Viceroy, and Mr. Morley succeeded Mr. Brodrick at the India Office. The latter change brought Kitchener up against demands for retrench-

ment and other Liberal shibboleths, and some of his reforms had to be postponed; but on the whole the two men worked well together. Lord Minto was a most friendly go-between. Soon after his arrival he wrote:—"I find him (Kitchener) very broad-minded, very ready to see both sides of a question, and perfectly easy to deal with, whilst his minutes on the questions we have had to consider since I have been here have been much the ablest and most moderate I have had before me." Nearly three years later, in another letter to Morley, Minto said:—"The more I see of him, the more I admire his ability, excellent judgment, and level-headedness. He would do splendidly in any position, and is a valuable asset which the country cannot afford to see put on the shelf. He is a curious personality, not attractive in manner, but has a kind heart buried away somewhere, and his inner tastes are much more artistic than military." But in spite of this praise and of strong outside pressure Lord Morley would not gratify Kitchener's ardent wish that he should go back to India as Viceroy. The unlikeness of type and ideals was too deep.

Perhaps it was the same sense of incompatibility that made the Prime Minister hestitate to employ Kitchener at the outbreak of war in 1914, until the public demand became insistent. He had already started for Egypt when he was recalled from Dover to become Secretary of State for War. It was his first employment in the War Office, for Mr. Brodrick had tried in vain to persuade him to serve on the Head Quarter Staff. He had to familiarize himself with its methods when the machine was dislocated by the tremendous strain to which it was suddenly exposed, and by the loss of many of its best officers. He had to feed the old army with men and stores, and to create a new one. Fortunately, his sound judgment and largeness of conception enabled him to take a true measure of the necessities of the case, and escape the easy optimism which prevailed. As he wrote to Sir John French:—"Believe me, had I been consulted on military matters during the last three years, I would have done everything in my power to prevent the present state of affairs in which this country finds itself." There was something of irony in the fact that his sharpest critic was the man who had been Chief of the Staff till within a few months of the war.

Sir George Arthur rightly avoids controversy, but the materials he gives enable his readers to form their own opinion on Lord French's complaints in connection with Kitchener's journey to Paris at the end of August, and the shortage of munitions in the spring of 1915. The depression caused by the failure at Festubert, and by an order to send some of his reserve ammunition to Gallipoli (to save time), led Sir John French to carry his griefs to the Press and the leaders of the Opposition; yet only a week before he had written to Kitchener "the ammunition will be all right."

These complaints might lead one to infer that relations were strained between the War Minister and the Commander-in-Chief, but this does not seem to have been the case. Their meetings were frequent and friendly, and nothing could be warmer than Sir J. French's language towards the end of 1914:—"We all feel here that we are absolutely safe in your hands, and we have the most unbounded trust in your support and help. I repeat what I have said before, 'Thank God you are there,' and I mean it. You are the one man I have always looked up to and believed in as a soldier, and I rejoice to be serving under you again." Kitchener for his part had written to Brodrick at the end of the Boer War:—"French is the most thoroughly loyal, energetic soldier I have, and all under him are devoted to him—not because he is lenient, but because they admire his soldier-like qualities."

On one point, it is true, they did not see eye to eye: French was a "Westerner" opposed to side shows; Kitchener was allured by the great possibilities of the Dardanelles enterprise. The East had a large place in his mind, and he was equally alive to what was to be gained by success, and to the risks we should incur by failure. When the subject was under discussion in January, 1915, he had no troops to spare for it, and he held that a purely naval attack on land forts was not likely to succeed. He was assured, however, that what had been done at Liège might be done in the Dardanelles by vessels like the *Queen Elizabeth*. Bowing to naval opinion he gave his concurrence, and was soon led on to promise troops enough to supplement and complete the work done by the Navy. But before the troops could arrive the ships made their attack and failed; and a landing by surprise, which might have succeeded, was no longer possible.

The painful story of the next nine months is told here very fully by extracts from the letters of Sir Ian Hamilton and Sir W. Birdwood. When the demands for men and yet more men could not be met then came the question of evacuation. Sir I. Hamilton estimated that half the force might be lost, and Kitchener told Mr. Asquith:—"I pace my room at night, and see the boats fired at and capsizing, and the drowning men." Happily it was accomplished almost without loss. Kitchener was sent out to judge the situation on the spot, and he was most anxious that the troops withdrawn should be landed at Alexandretta, to counteract the loss of prestige and to guard Egypt. He was not allowed to have his way. The Turco-German attack on Egypt which he foresaw took place in the spring of 1916, but proved a failure.

At the end of 1915 Sir Douglas Haig succeeded Sir John French as Commander-in-Chief in France, and Sir William Robertson came to the War Office as Chief of the Imperial General Staff. It was laid down that he should be the medium for submitting reports and

proposals to the War Council and for notifying its decisions. There was a general impression that this meant a clipping of Kitchener's wings; but Robertson was the man of his choice, and he welcomed the change, both because it would lessen his excessive burden of work, and because the new Chief of the Staff would be "a most valuable buffer against plans of campaign emanating from individual ministers who might exercise highly trained faculties of persuasive rhetoric to commend to the authorities the children of their too fecund imaginations."

After all, Kitchener's great work in the war was not as a strategist, but as the creator of the new armies, and one could wish that his biographer had given fuller details of the way in which this stupendous task was carried out. It was as an administrator rather than as a soldier that he showed his greatness. He does not seem to have taken much interest in the art of war, either on its tactical or its technical side, apart from the particular problems that he had to solve.

Of the tragedy of the *Hampshire* Sir George Arthur says little, but he states—not as a matter of surmise, that "by an unhappy error of judgment an unswept channel was chosen for the passage of the cruiser; and Kitchener—the secret of whose journey had been betrayed—was to fall into the machinations of England's enemies, and to die swiftly at their hands."

Some lines written of an Elizabethan worthy were happily applied to him:—

"The waves became his winding-sheet,
The waters were his tomb;
But for his fame on earth and sea
Was not sufficient room."

STRUCTURAL STEELS.

FROM A LECTURE GIVEN AT THE S.M.E. BY MR. HARRY BREARLEY.

ONE of the questions frequently put to Engineers, military or otherwise, is whether a particular structure will bear a given stress. To answer the question, consideration must be given to the design of the structure and the " nature " of the material of which it consists. These considerations modified to some extent by experience, enable the capable engineer to approve of this or disapprove of that structure with a certainty which is justified by results.

As steel is one of the materials which enters largely into your various structures, it is proposed that we should say something about its " nature " in order that you may select (or reject) it with good reason to create your design and fulfil your purposes. The basis of selection which ought to appeal most strongly and directly to engineers is that relating to the internal design of the material itself and the nature of the constituent parts of the design. If from this standpoint we can explain the known properties of structural steels, and develop those properties less well known, we may perchance not only impart information, but also provide an instrument of thought whereby the choice of the right material will be a simple matter. Closely bound up with this aspect of the subject, once we know the interior design of our material, is the prospect of modifying it to suit our varied purposes. And if we are so far interested there should be no difficulty in devising tests, other than those which belong to the wrought iron age, to determine and control the properties of steel and predict its likely behaviour under given circumstances. Such an ambitious programme cannot be covered in a single lecture, but unless I fail in my purpose we shall want to carry the subject further along these lines and test it by experiment at many points.

Like all solid metals, steel of all kinds is crystalline. In passing from the liquid to the solid state, the crystals grow from the cooling surfaces or form freely in the mother liquor and remain suspended there or fall downwards. When cast at a temperature much above its melting point, the solid steel consists almost entirely of crystals growing from the cooling surfaces as in *Fig.* 1. When cast at lower temperatures, the interior portion consists of crystals which have formed freely and wandered in unpredictable ways to different parts of the ingot as in *Fig.* 2. These crystalline characteristics,

impressed on the material as it freezes, are never entirely lost however much the material may be forged or rolled, and the influence they exert on the properties of steel castings is, as you may imagine, of first-rate importance. We must, however, ignore these differences, and many others due to methods of melting steel and casting ingots, in favour of our immediate subject.

The forging and rolling of steel may alter the relative shape of its crystals and decrease their size, but it does not destroy them. If we imagine that pure iron has been melted and cast and forged into a bar, a section through such a bar, after polishing, etching, and suitably magnifying, would present the appearance of *Fig.* 3. The cell-like enclosures are merely outlines of the sectioned crystals which have been made visible by appropriate etching.

The main distinction between iron and steel is the presence in the latter of greater or lesser amounts of carbon. The carbon may be added by a cementation process as in the manufacture of shear steel and the common production of case-hardened objects, or it may be added by the simple expedient of melting together wrought iron and charcoal. By whatever means the carbon is added, and quite independent of the process by which the steel is made, we find always on the polished and etched section a greater or less part of it occupied by dark areas as in *Fig.* 4; and the physical effect of these dark areas as they increase in size or number, is to make steels containing them harder and harder.

If a specimen of steel instead of containing ·15% carbon as in *Fig.* 4 should contain ·30% carbon as in *Fig.* 5 the dark parts are proportionately increased in area, as you will see by making a comparison. With ·45% carbon (*Fig.* 6) these areas are still further increased and you may note that the light and dark parts occupy approximately equal areas. This continues in the same way until at ·90% carbon, the entire field consists of dark etching areas.

These dark or pearlite areas are not themselves structureless. At higher magnification they are seen to consist of apparently light and dark laminae (*Fig.* 7) which have been recognised as alternating plates of practically pure iron and iron carbide. If by the time ·90% carbon has been added all the available iron has been used to form the pearlite laminae, then all further additions of carbon may form iron carbide, but it must exist in the steel in some other form. This it actually does, and we find that it occurs usually as carbide envelopes about the crystalline grains (*Fig.* 8), or as comparatively massive plates lying parallel to the axes of the crystalline grains (*Fig.* 9) or in both forms (*Fig.* 10).

From this brief explanatory *résumé* it appears that the introduction of carbon into iron to produce steel modifies its properties by forming within it a new and distinctly separate substance called carbide of iron. This carbide is very hard and consequently brittle. It is

very finely dispersed and intimately mixed with the iron so long as the amount of carbon does not exceed one per cent. but any excess exists in a comparatively coarse state in positions favourable to the starting and propagation of cracks. From these considerations the hardness of steel will obviously increase as the pearlite grains occupy a larger portion of the material. It is equally obvious that the toughness will decrease as the ferrite grains, composed of soft flexible iron, become less. But the toughness may be considerable so long as each small plate of carbide is cushioned between two plates of soft iron, *i.e.* until the amount of carbon approaches one per cent. When, however, the carbide must form comparatively large plates, or brittle envelopes separating each grain from its neighbour, the intergranular strength becomes less and the mass as a whole exhibits signs of brittleness.

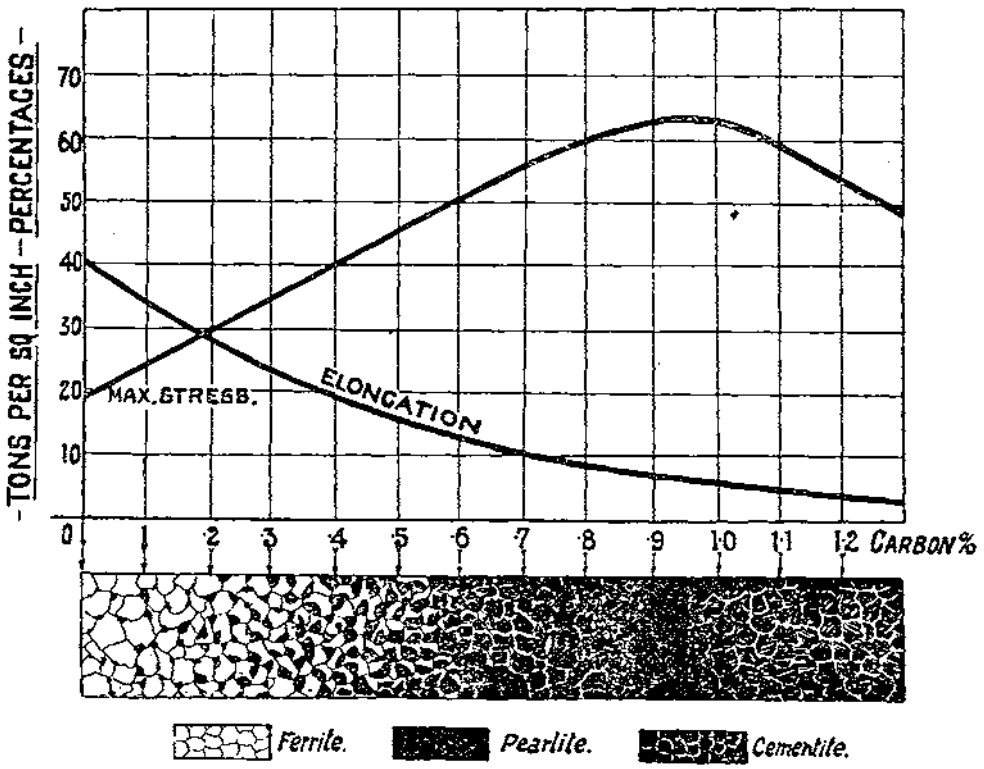


FIG. 11.

These structural facts and the correlated mechanical properties, which are in line with general experience, may be represented graphically as in *Fig.* 11 Such a picture summarizes practically all we knew about the properties of steel up to 20—30 years ago. Tool steels were hardened, mainly to improve their cutting

properties, and commoner articles, such as springs, were hardened and tempered for special purposes, but the heat-treatment of structural steels with the idea of improving their general properties was hardly dreamed of.

The addition of special alloys to steel in order to improve its value as structural material, was practised some years before the usefulness of heat-treatment was realised. Logically, however, the use of alloys should have come afterwards because we cannot appreciate the meaning and value of alloy steels until we understand what is meant by heat-treatment.

As a crude but striking example of the meaning of heat-treatment, we may take a piece of mild steel in the form of a casting or overheated forging. Structurally it consists of coarse crystalline grains built up of ferrite or pearlite as seen in *Fig.* 12. On gradually raising the temperature of this material and quenching specimens at suitable stages, nothing appears to happen until at about 750° C. a quenched strip instead of bending breaks off short on being struck with a hammer. The general outline structure (*Fig.* 13) appears to be unaltered, but if we compare the dark areas of the original material (*Fig.* 14) at larger magnifications, with those of the strip quenched at 750° C. (*Fig.* 15) we see that the laminae composing the pearlite have inter-diffused. These inter-diffused areas are now quite hard, although the white areas are as soft as before.

At any higher temperature the transformed areas begin to spread outwards, and at 780° C. though the outline of the original crystalline grains is visible (*Fig.* 16) it is obviously being over-run by its neighbour as though it were a living thing. At 800° C. the original crystal outline is barely distinguishable (*Fig.* 17) and at 850° C. we have neither light nor dark constituents but a uniform mass of crystals (*Fig.* 18) of much smaller size than those we started with. When the inter-diffusion is complete the large crystalline grains break up into smaller ones. Why this refining occurs I am not competent to explain but the extent of it may be illustrated by comparing the original grain size with the refined grain size (*Fig.* 19).

If the specimen is quenched from this inter-diffused condition, we call the process hardening. If the specimen is allowed to cool in the air we call it normalising; and if the cooling is purposely made very slow we call it annealing. The advantage of the operation lies in the fact that the larger crystals have been replaced by smaller ones. These smaller crystals may be trapped in the hard condition; or during slow cooling the transformations will take place in a reversed order and the material becomes soft again as it was to begin with, but its structure in the slowly cooled condition is entirely changed as may be seen by comparing the two photos in *Fig.* 20.

The effect of a normalising operation on the mechanical properties of an overheated steel is illustrated by *Fig.* 21. The maximum stress, as might be expected, remains practically unaltered and so does the elongation %. The yield point rises because the crystals are smaller, and therefore more effectively reinforce the strength of the so t ferrite particles which would of course be the first to yield under stress. But the most striking effect is shown by the increased impact figure which reaches a maximum at a temperature corresponding to complete inter-diffusion of the micro-constituents and thereafter falls because the higher temperature begins to enlarge the size of the refined crystals. The first effect, therefore, of appropriate heat-treatment, is to replace coarser crystals by finer ones, and this in itself is a mechanical advantage.

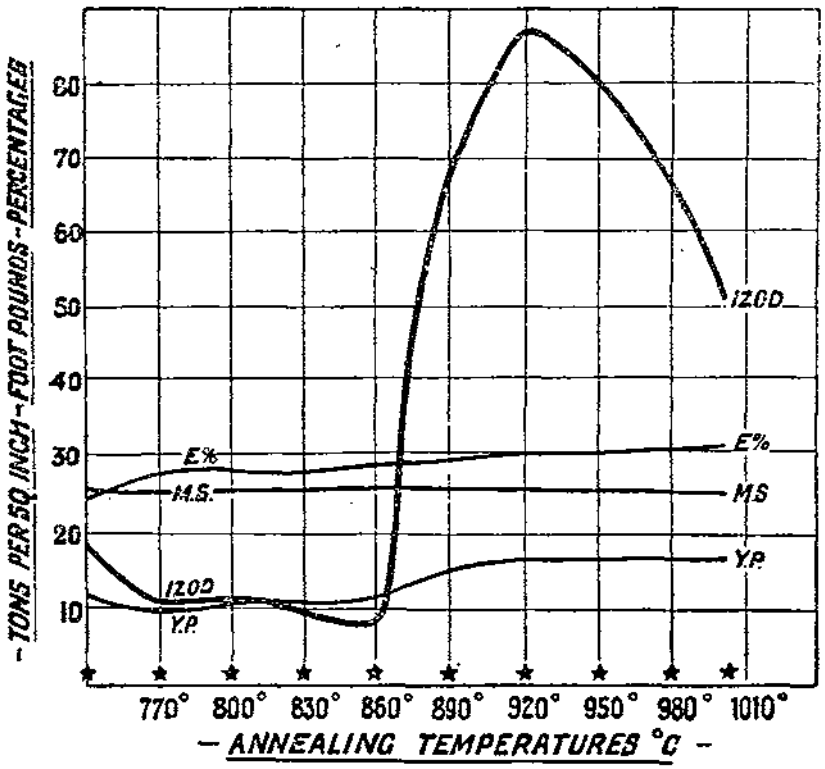


FIG. 21.

If the temperature of our specimen is reduced quickly, by cooling in some quenching medium like water, we preserve the material more or less in the inter-diffused condition, and it is also hard. Both these features are advantages. The first because we are now dealing with a more homogeneous substance, and can therefore more reliably depend on its behaviour under diverse conditions of stress, and the

second because we can barter the hardness, or as much of it as is not wanted, for increased toughness.

Generally speaking, the extent to which the toughness of a material can be improved by heat-treatment, depends on the extent to which it can be hardened by quenching. As, however, the heated steel, whose constituents are in the diffused state, passes again into its normal soft condition at a certain rate, it cannot be kept in the inter-diffused condition and be made hard unless quenching cools it at a still greater rate. Thus a pure carbon steel bar, say, one inch in diameter, might be hardened in water, but it could not be made very hard by quenching in oil. If we add also, say, one per cent. of manganese, the bar would be practically as hard when quenched in oil as when quenched in water, the reason being that the added manganese delays the "rate" at which the diffused constituents re-appear as separate substances. Any element, therefore, which, added to steel, delays the rate of reappearance of the diffused constituents enables the steel to be hardened by cooling in oil, or in extreme cases, by cooling in air. Also for the same reason such added elements enable larger masses of steel to be hardened almost as completely in the centre as on the outside.

This brings us at once to a consideration of alloy steels. If the added alloy confers additional toughness, and at the same time permits us to induce great hardness in considerable masses of steel, so much the better. The increased hardness, however, is the feature on which we must rely because such hardness can be bartered for a degree of toughness which cannot be purchased, in association with other desirable mechanical properties, in any other way.

Let us see what this means to the Engineer who wants to use weight sparingly, and at the same time produce strong structures subject, may be, to severe shocks. A piece of ·3% carbon steel, say about one inch in diameter, when quenched in water would have a tensile strength of about 50 tons. A piece of steel containing 3% nickel, but in all other respects identical, would have a tensile strength of about 100 tons. If we temper the nickel steel we can reduce its tensile strength to 50 tons, and in exchange for the lost hardness we get a great deal of toughness. By comparing the ductility and toughness of two steels having the same tensile strength, or the hardness of two steels having the same ductility and toughness figures, we may fairly choose which of them is the better for any given purpose. The mechanical properties of the two steels before us were found to be:—

Composition.					Mechanical Properties.				Izod
C.	Si.	Mn.	Nickel.		Y.P.	M.S.	E%	RA%	Impact Foot pounds.
·33	·15	·63	*Nil*	....	?	52·8	16·0	43·2	10 & 11
·33	·13	·63	3·28	....	43·2	52·9	25·0	64·9	100 & 104

Suppose now we consider such a steel as the one used during the war in large quantities in the manufacture of crank-shafts and connecting rods for aero engines. As small bars it would harden when cooled in air, and in fairly large bars it would harden when cooled in oil or water, up to a tensile strength of 100/120 tons. By tempering hardened bars at gradually increasing temperatures, we lose hardness but gain other valuable properties. If the results of tests made on the bars reheated to the various temperatures are tabulated or plotted (*Fig.* 22), we have before us a picture showing a wide range of mechanical properties which can be induced at will in the same kind of steel in order to serve diverse purposes.

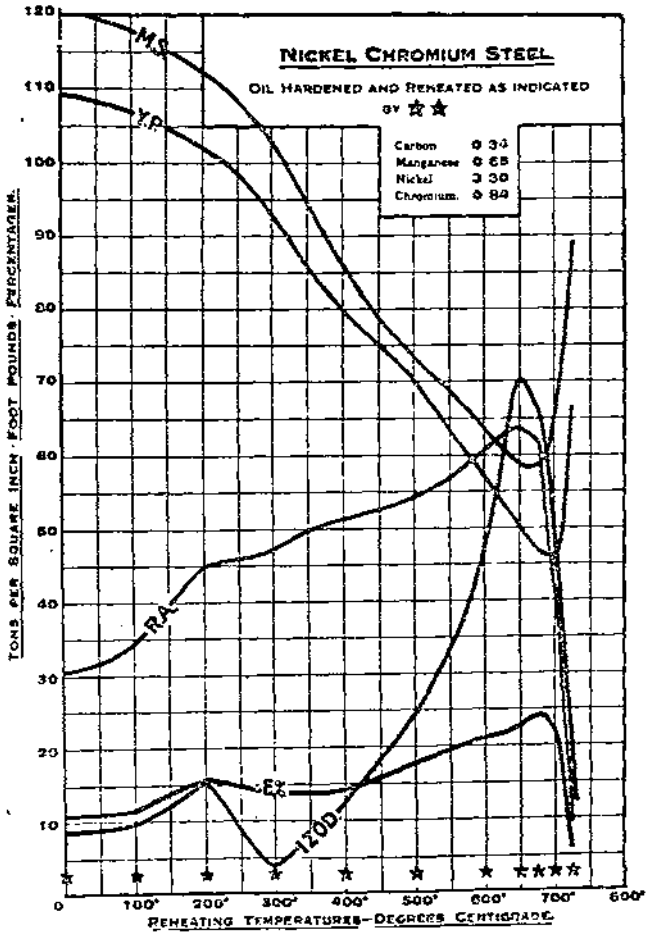


FIG. 22.

For many years a few steelmaking firms have been testing all known kinds of steel and arranging the tabulated results in the order of chemical composition just as a dictionary is arranged in

alphabetical order. Such a collection of results which may be called a dictionary of mechanical properties, would, if available, be of great value to engineer designers. But from it all, two things stand out clearly. First, that alloy structural steels are bought to very poor purpose unless they are used in the heat-treated condition, and second, that ordinary carbon steels of not too great a mass—even common structural steels—may be advantageously heat-treated, and when so treated are often superior to alloy steels used in the forged or annealed condition. These statements ought to be supported by evidence, but although evidence in plenty is available, time is not.

One of the most useful constructional materials is wood. The varying hardness and toughness of wood is known intimately only to those who work with it, but everybody knows something about the grain in wood, and a novice who used wood in a stressed structure without regard to the direction of its grain would probably get into trouble sooner or later. The grain in forged or rolled steel is just as real as it is in wood but it is not so obvious. After boiling in dilute acid, a piece cut from a bar of mild steel will have an appearance something like *Fig.* 23; on one face is seen the length, and on the adjacent face the end of the grain is visible. Obviously, severely stressed material ought to be arranged with its grain most favourably disposed towards the direction of stress.

To obtain some quantitative idea of the influence exerted by the direction of grain on the mechanical properties of steel, an ingot was rolled into a flat bar. From this bar duplicate test pieces were cut at angles inclining variously to the length of the bar. The results of the tests are plotted in *Fig.* 24. Kindly note the elongation and reduction of area %, both fall rapidly when the pull on the tensile test piece is exerted at an inclination to the grain of greater than 40°; also that the impact figures are the most sensitive indication of the deteriorating effect of grain, as they fall continuously from nearly seventy foot-lbs. down to seventeen foot-lbs.

The notched bar impact test has been defined as a means of measuring the effort required to propagate an incipient crack across a given area of material. Personally, I think very highly of it and would accept its indications together with a Brinell hardness test, in preference to the results of the most elaborate tensile and bending tests. But, however right or wrong that view may be, there is no test so convenient or sensitive if we desire to study the influence of grain in steel. A gear blank may be cut from a round bar and if teeth are cut across its edge at right angles to the faces, such teeth are apt to shell off in service because the grain is least favourably disposed towards the stress. A blank made by hammering in the corners of a flat bar to produce a circular disc is not much better because the resistance of the teeth would vary from a maximum to a

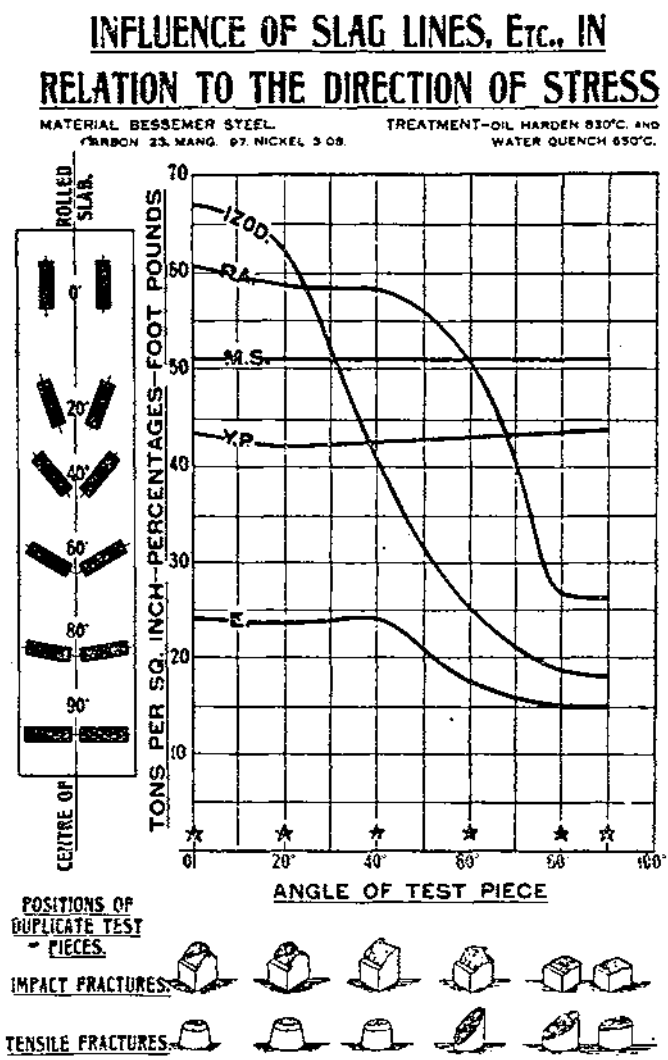


FIG. 24.

minimum according to their position (*Fig.* 25) and a gear is no stronger than its weakest teeth. The most satisfactory way of producing a gear blank is to up-end it from a bar of much smaller diameter.

By developing the grain, much can be discovered about the way in which an article has been forged. Six-throw crank-shafts for aero engines were produced during the war by forging and twisting the webs to the required angle, by gapping bars forged to a trifoil section and by drop stamping. The machined crank-shafts were alike in appearance, but they could be easily distinguished by examining the flow of the hot steel as shown by the grain (*see Figs.* 26, 27, and 28). Cranks-shafts of each kind were cut up into impact

test pieces from which results closely following variations in the direction of the grain were obtained. Compare the grain structure of *Fig.* 28 with the impact results of *Fig.* 29.

I have been asked to say something about high speed steel. Unless you are willing to listen to another and entirely different lecture, it would be difficult to indicate anything more important or more objectionable in high speed steel than grain. If high speed steel in the toughest possible condition is broken along its length, the fracture has a reedy appearance. The explanation is simple. In the ingot state the crystalline grains are surrounded by brittle envelopes of complex carbides (*Fig.* 30). At forging temperatures these are attenuated but rarely destroyed by diffusion and consequently are elongated with the bar. In small bars the envelopes may appear to exist as parallel lines, but in either small or large bars the effect is similar. This explains why cracks in high speed turning tools are usually along the shaft; why teeth in cutters shell off at the root; and why high speed steel screwing dies are more popular than high speed steel taps.

If the fundamental structures have been clearly presented then in relation, neither to high speed steel nor the various forms of structural steel, is it necessary to emphasize the correlated physical properties; they should speak for themselves to military engineers who are accustomed to estimating the strength and reliability of structures of a visible design built of known materials.

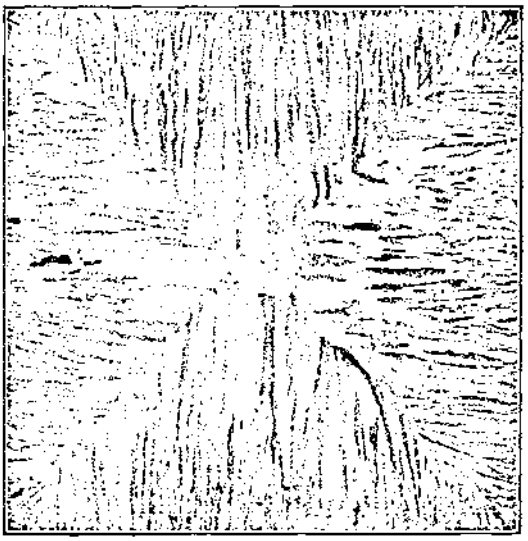


FIG. 1.

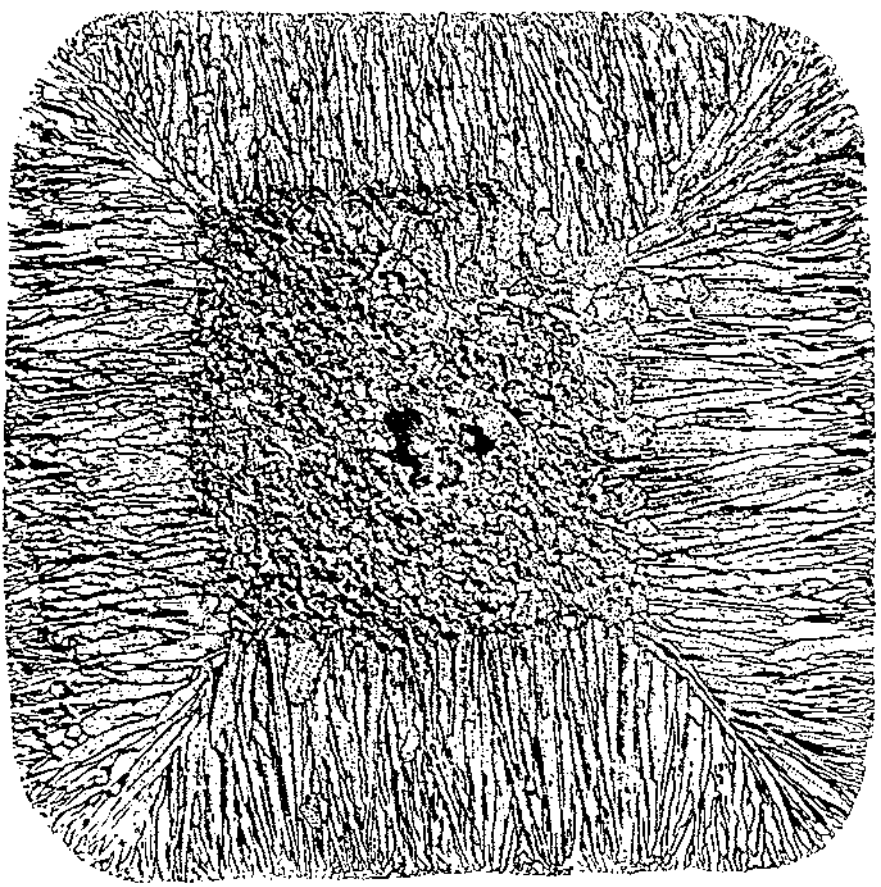
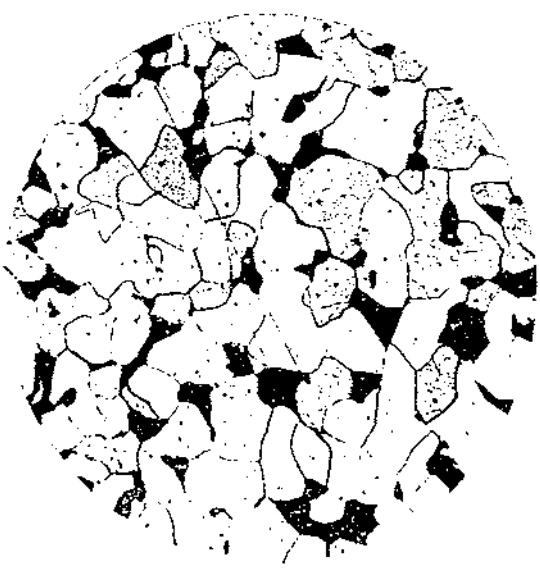


FIG. 2.

FIG. 3.



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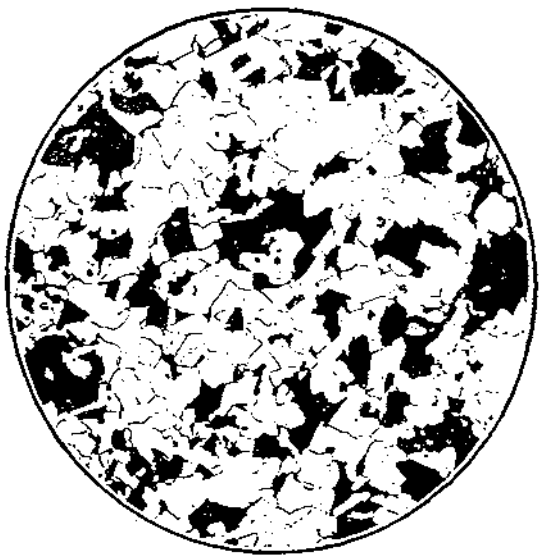

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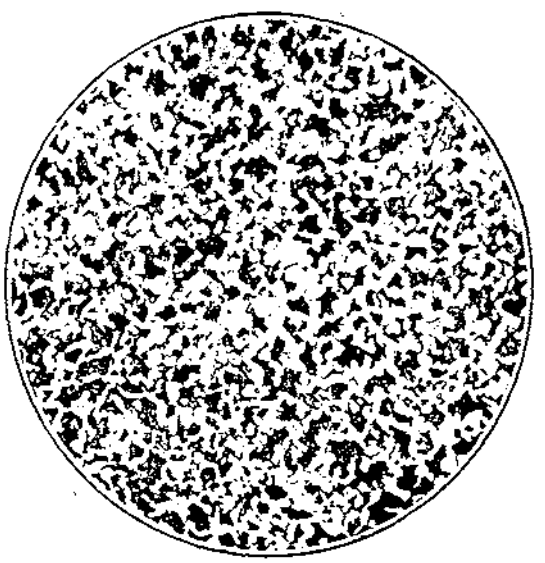

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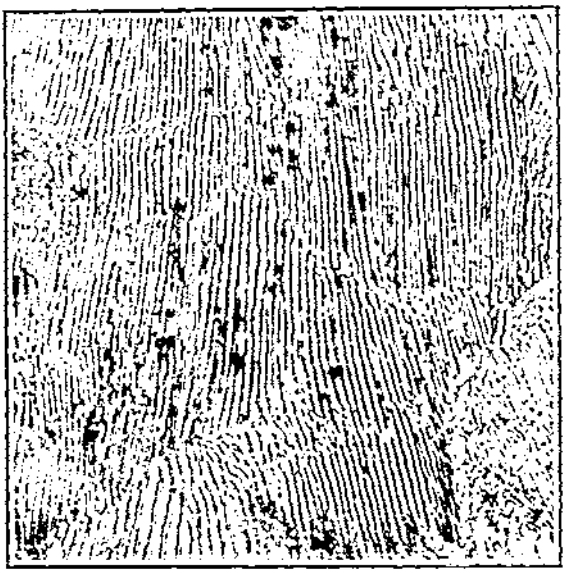

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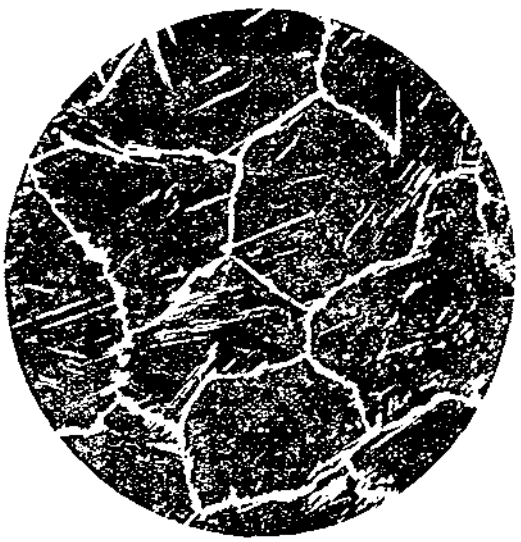

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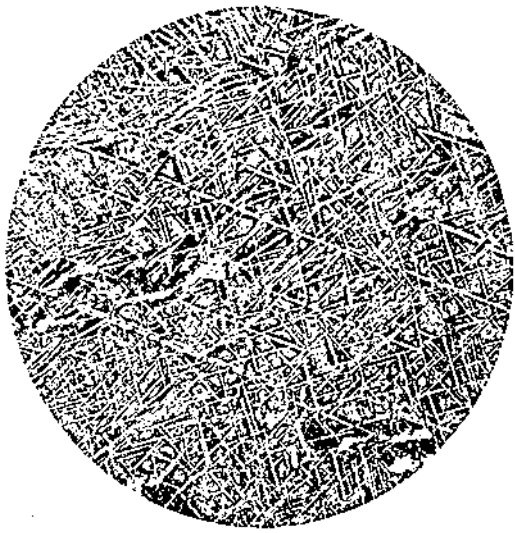

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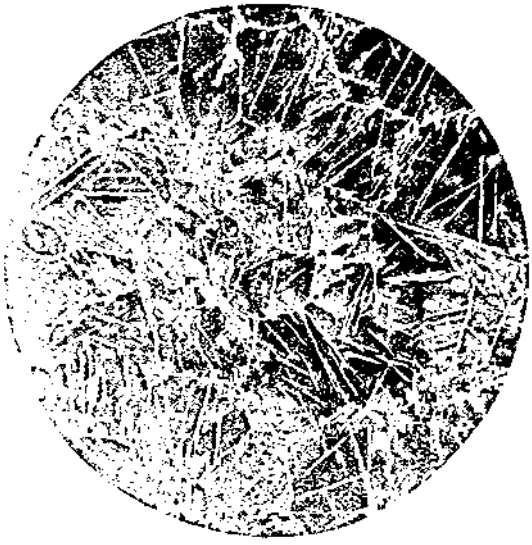

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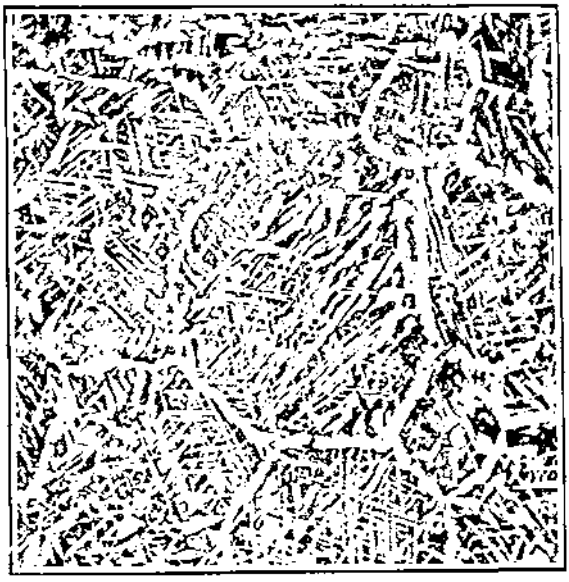

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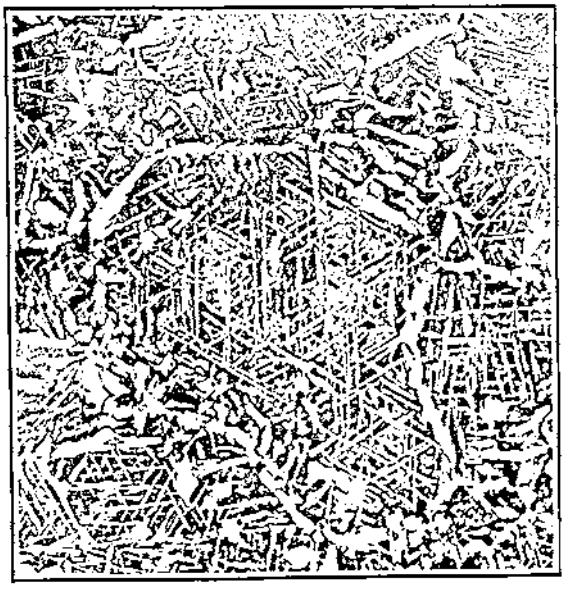

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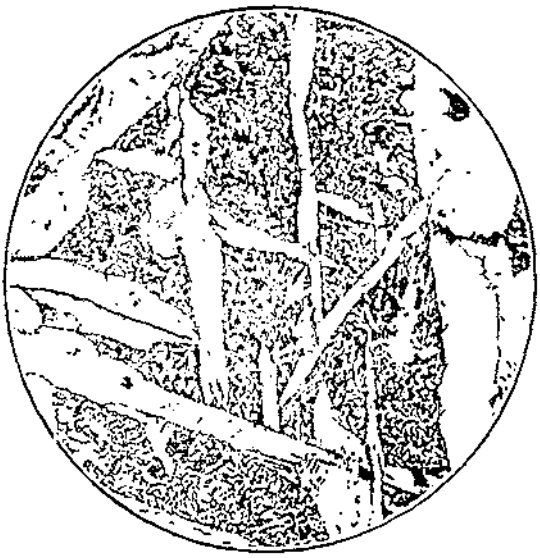

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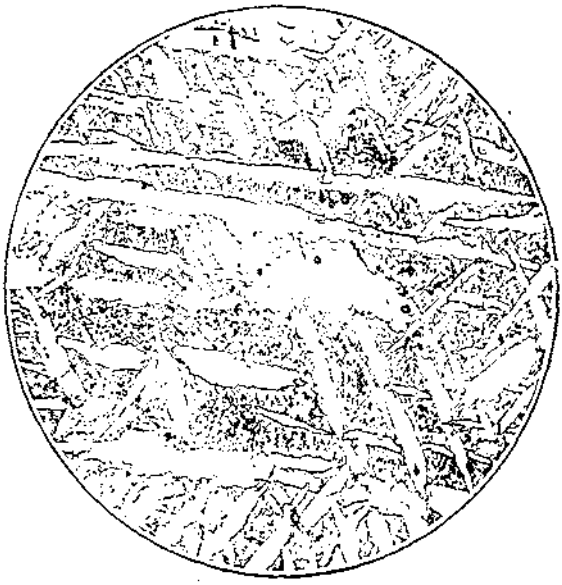

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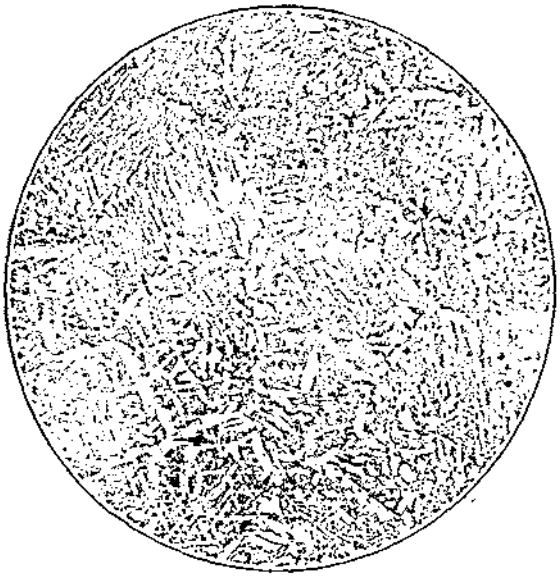

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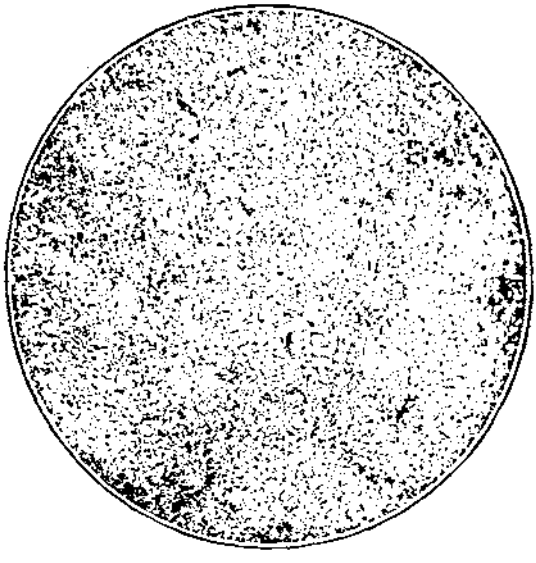

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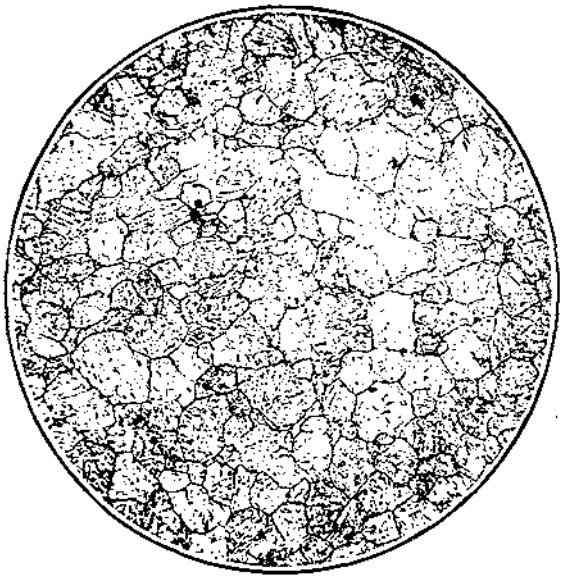

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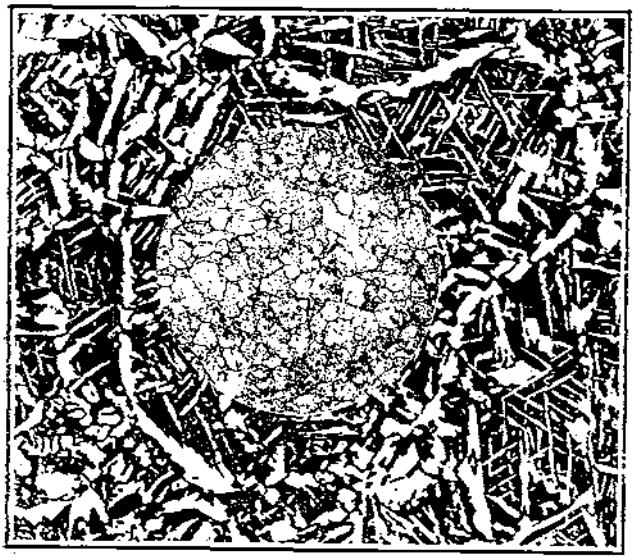

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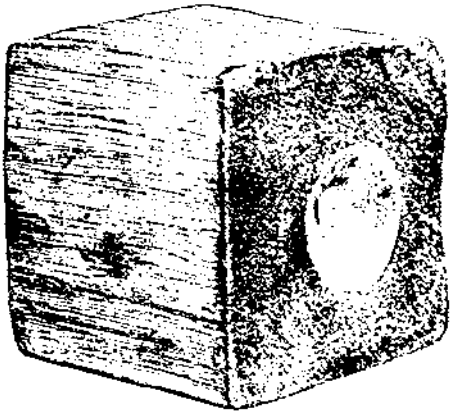

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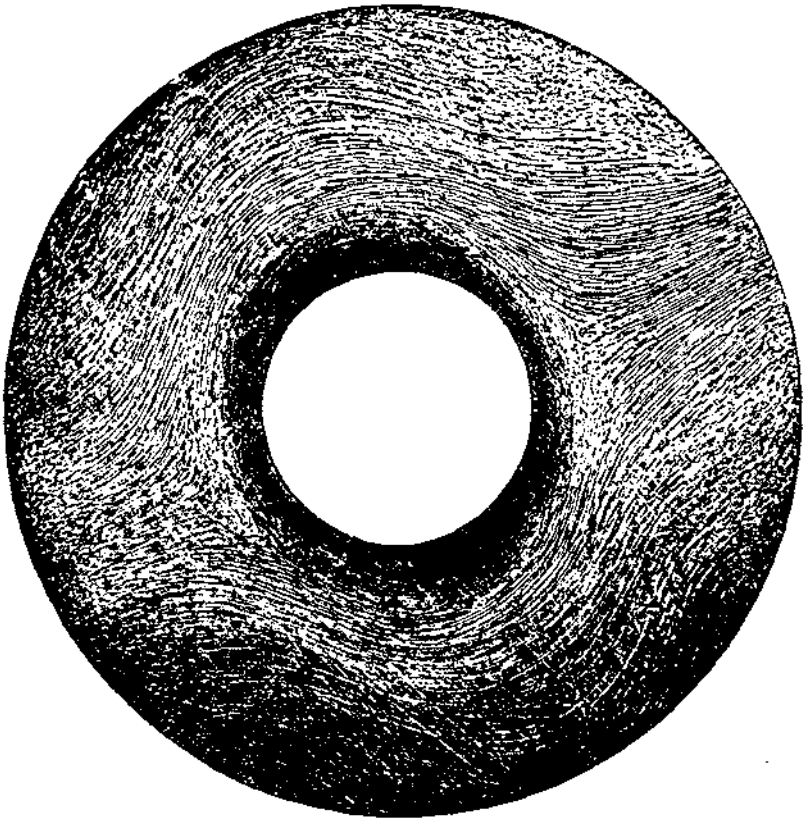

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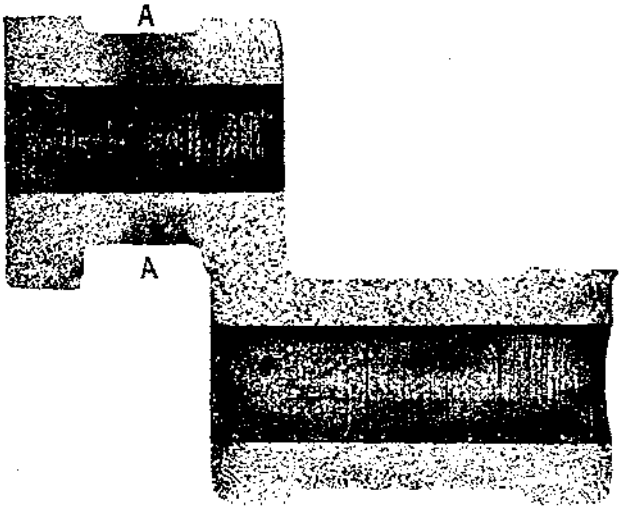

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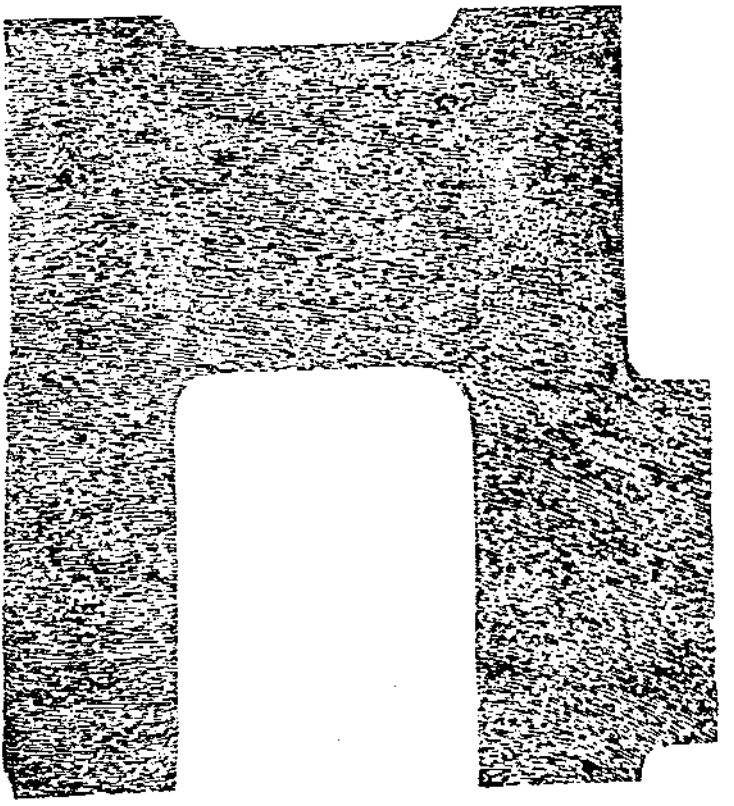

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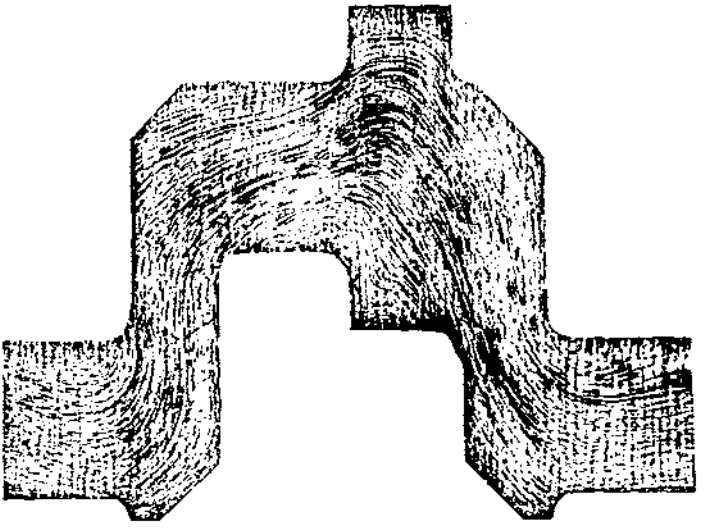

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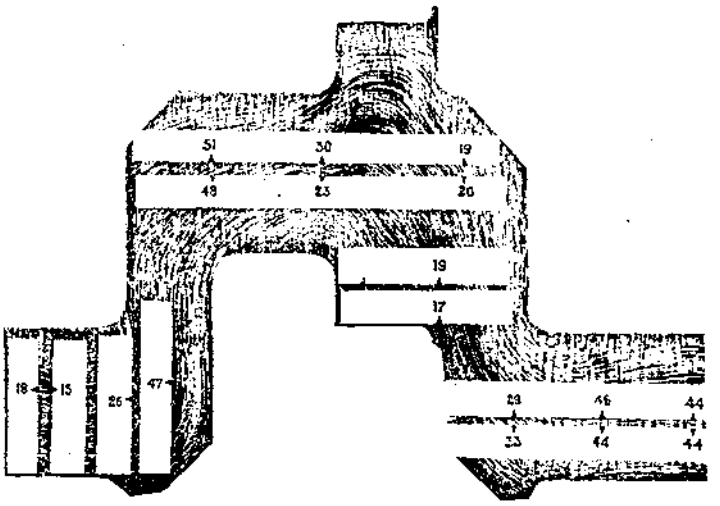

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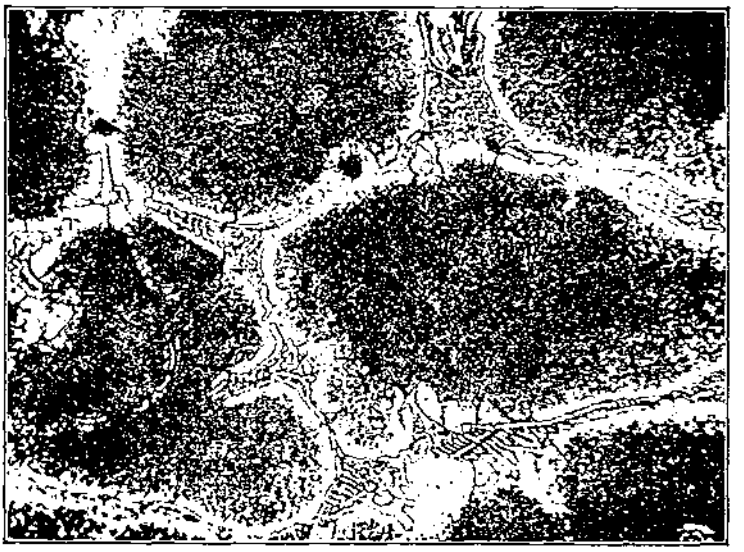


FIG. 30.

SCIENCE AND THE NATION.

By COLONEL THE RIGHT HON. LORD SYDENHAM, G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., F.R.S. (late R.E.).

By the kind permission of the Executive Committee of the British Science Guild.

AT the Annual Meeting of the British Science Guild,* held on Tuesday, June 8th, Lord Sydenham delivered the following Presidential address :—

In a letter which I lately received from a distinguished American and a warm friend of this country, he says :—

> " To me the greatest problem of the hour is the strike, which I think a greater menace to the world than Kaiserism ever was, and the fundamental cause of the strike evil is the perverted psychology of the working classes which in turn is the inevitable result of conditions brought about by the substitution of the machine for the man, from which no escape seems possible."

There can be no doubt that the " strike evil " has grown to dangerous dimensions. From being the legitimate weapon of the weak against injustice which could not otherwise be redressed, it has become the instrument of caprice or even of blind passion which may be resorted to without waiting to ascertain facts or to seek conciliation. Large numbers of men will suddenly cease work because of some incident at a distance which causes them irritation, thus intervening in disputes which do not concern them. The advice of responsible labour leaders may be disregarded and their authority may be set at nought, reducing the Trade Union organizations to a farce. Or powerful groups may threaten the life of the nation if some measure, which they have been induced to demand, is not immediately granted. We have seen questions of national policy made the occasion for such threats by which the authority of Parliament is defied, and it is because of this apparent readiness to throw over constitutional methods that foreign propagandists have thought it worth while in recent years to spend largely in the hope of utilizing British organized Labour for their own purposes.

While the strike, in the new form of direct action, is a flagrant violation of the principles of democracy, it is economically disastrous

* Offices, 6, John Square, Adelphi, W.C.2. Secretary, Miss A. D. L. Lacey. The objects of the League are explained in Lord Sydenham's address.

in proportion to the loss of production entailed. Strikes during the war, by hampering the supply of the armies in the field, threatened the lives of our soldiers and prejudiced the cause of the nation. It is impossible to estimate the total national loss they have inflicted since the armistice, and some of them have been unjustified and futile. The moulders' strike affected many industries, created extensive unemployment, left arrears not yet made good, and gave nothing to the strikers which they could not have gained by remaining at work. The indirect results of the strike fever are far-reaching, because they cause the uncertainty which checks enterprise, and they may involve the loss of valuable contracts on which employment depends. As soon as foreign competition again begins to be felt, industrial conflicts will be gravely injurious to the export trade by which we exist. It is certain that the present critical economic conditions can be faced and conquered, but only by honest hard work of hand and brain, by the self-sacrifice which would ensure thrift among all classes and by rigid economy in public expenditure. There are no signs that these supreme national needs are realized, and we appear to be drifting into a grave economic position. While the newly enriched classes have been spending lavishly on superfluities, we see the bricklayer who deliberately restricts his efforts although housing accommodation is the prime necessity of his class, and the coal miner, who with increased numbers, shortened hours, and good wages, does not approach the pre-war output. All this directly and indirectly helps to create the high prices of necessaries of life. The total loss of coal raised is nearly 50 million tons a year, compared with the figures of 1913, and our coal export trade has dwindled with consequences which must be serious.

If we fail to rebuild the national prosperity on a broadened basis, and if the revolutionary movement supported by foreign agency assumes an active form, the cause will be mainly psychological. My American friend attributes the troubles in his country to the "substitution of the machine for the man," which he considers has "perverted the psychology of the working classes." I believe that the menace to civilization, which we can plainly see, arises from a perverted mentality which has affected all classes. The war with all the losses, the restrictions and the privations which it entailed, aggravated psychological tendencies which were visible before. If it is true that science applied to industry is a cause of the present unrest, we who desire the full enfranchisement of science may well consider where the fault lies.

In less than 100 years our country underwent political and economic revolution so continuous and so apparently successful that psychological perversion was perhaps inevitable. The reign of the machine changed the whole life of the country, and became more and more imperious. The existence and the maintenance of the present population depends absolutely upon it. Where, as in

Russia, it has been broken down by an infamous government, we see starvation, misery, and reversion to primitive barbarism in a rich country easily able to feed the people and to supply raw materials for industries. If it were to break down here even for a time, the suffering would be greater and the disaster would be irreparable.

Politically the advent of the machine transferred power to the towns, left us with a relatively small rural population, and caused the vital industry of the land to be disregarded or relegated to a subordinate position. While the national wealth grew rapidly and riches fell to a new social class, including many manual workers, great towns sprang up, and from want of forethought the accommodation of their constantly swelling populations failed to fulfil the requirements of sanitation or even of decency. From this neglect, which we realize too late, a whole host of evils has sprung. The greatest economic change, was, however, that a small population living mainly on internal resources was quadrupled and came to depend for existence on imported food and raw materials, which could be paid for only by the export trade and rendered secure only by naval supremacy. In no other great country is this condition so inexorable as with us, and, unfortunately, the consequent demands on our production are not sufficiently understood.

I think it may be fairly said that the psychology of the mercantile and industrial classes was warped by concentration upon the organization and extension of great businesses and by the comparative certainty with which, so long as Great Britain had little competition to face, wealth could be accumulated. Success always has its snares, and it was perhaps mainly preoccupation that in too many cases induced forgetfulness of some of the responsibilities involved. Labour presented itself at each centre of new industry, and the conditions of life of the workers were too generally regarded as lying outside the sphere of the employer, while the large numbers dealt with excluded the personal relations between employers and employed, thus entailing want of knowledge of the needs and the habits of thought of the latter. The reign of the machine thus led to the mechanical handling of human beings, which must fail in the long run. There have always been employers who studied the welfare of their manual workers; there are mining villages which are models; but it must be admitted that the perversion to which I refer led to excessive working hours and inadequate wages in many cases, and to other conditions which promoted discontent. The war has changed the outlook of many employers of labour. There is now a general desire to meet all reasonable demands. Conciliation by frank negotiations is earnestly sought, but it is not possible quickly to remove evils that have accumulated, and labour having tasted power, does not recognize the new opportunities and the new sympathies offered.

Upon the psychology of the manual workers, the reign of the

machine exercised a profound influence. The dwellers on the land unconsciously assimilated some great lessons which education so far has failed to impart. They were brought face to face with the inexorable laws of nature. They saw the results of their labours and could trace failure to its causes. They became aware that something could not be obtained out of nothing, and that there was a relation between production and employment. They realized what capital could do for the land and the effect of its absence or unwise employment. Above all, they learned patience. I think that we under-rate the psychological value of the special training which the life of the country provides. The land will come more and more under the reign of science, but the land worker cannot fail to understand the increase of production which will follow from the scientific application of capital to his industry. The land workers now form a small proportion of the whole population, and the psychology of labour as a whole is mainly determined by life in the town and the factory. In the small business, employer and employed were closely associated, and the latter knew the conditions which brought success or failure, while the simple finance involved was within their comprehension. The reign of the machine created huge undertakings. The employer, often working with his men, was replaced by the Board of Directors sitting in secret. The financial complications became unintelligible to the workers who did not understand the brain activities, the thought and the anxieties involved, or the foreign markets on which their employment may depend. There is a sense of satisfaction in the exercise of skill, but the automatic machine performed highly skilled operations while demanding only a certain amount of care and attention. Physical exertion was immensely reduced; but the healthy fatigue which it brings was replaced by the nerve stress of the factory, of which investigations during the war have taught us much. The change must have tended to produce mental irritability, and when these and other conditions, including the dread of unemployment, are taken into account, labour unrest seems a natural result. Many manual workers came to believe that they were unconsidered though essential factors in a ruthless system devised for the benefit of capitalists, and they were therefore ready to accept the doctrine forced upon them that only by the destruction of capital could they attain higher standards of life. It is true that capital in private hands may be tyrannically used, and that this has happened in America especially. Capital in the hands of Trade Unions may also be used for tyrannical purposes. This is a danger to society which must and can be prevented. But it is equally true that wages are highest where capital is most abundant, that the destruction of capital in the war is one of the causes of our own difficulties and of the misery in Europe, that most of the capitalists in this country are persons of small means and that any attempt to deny the right of private saving and to substitute

nationalization under a Socialist or Communist State will entail the employment of labour under rigid discipline. It would be easy to show that this is inevitable; but we have the appalling object lesson of Russia where civilization has been destroyed by a small minority of self-constituted dictators who are using forced labour in the vain hope of restoring the ruin they have brought about. What this country needs is many more capitalists or, in other words, a much wider distribution of capital.

The problem before us is to reconcile capital and labour, each necessary to the other, and to recognize that a perverted psychology has affected both. Only by goodwill, involving mutual concessions, can the spirit of unreasoning hostility be exorcised, the manual worker be given a new interest in his labour with new opportunities of economic advancement, and this old country of splendid traditions be saved from disaster.

Can the reign of the machine be rendered beneficient to all alike? Can science, which has been the creator of conditions which have favoured the spread of revolutionary ideas, help to provide the antidote? It is a remarkable fact that, while scientific discovery was transforming the national life, there was no corresponding development of science training in circles entrusted with government and administration. When foreign competition began to be felt, it was quickly realized that some of our industries had fallen behind in utilizing the gifts which our leaders of science offered them, and that the Germans had passed us in the great domain of chemistry especially. If this neglect showed itself in quarters where there were strong inducements to turn science to the fullest account, it was certain to prevail in government departments with far more serious consequences to the nation. In a lecture delivered nearly 70 years ago, Professor Tyndall said:—

> "I state nothing visionary when I say that in a country like ours, whose greatness depends so much upon the applications of physical science, it would be a wholesome and natural test to make admission to the House of Commons contingent on a knowledge of the principles of Natural Philosophy."

And he went on to make a powerful plea for the study of physics among the manual workers, "not only as a means of mental culture, but also as a moral influence." Science has immensely extended its dominion since that day, and has become far more closely connected with the welfare of the nation, and, therefore, more urgently needed in every branch of Government. Yet in Cabinets, in Parliament, and among our representatives abroad, Governors, Ambassadors, and Consuls, training in science is conspicuously absent. We have a great and capable Civil Service, which wields large powers in administration; but even a moderate knowledge of the principles of science is not considered a necessary part of its

equipment. Among the permanent heads of the departments of State, therefore, an essential qualification is wanting. Even the Board of Education is completely swamped by officials who have only had a literary training and may have inherited a traditional disregard of science as an educative force. In the Treasury, now unfortunately a large spending department, in the Foreign Office and the Colonial Office, which must be continuously dealing with matters demanding some scientific knowledge, there are scarcely any high officials able to speak with authority.

The war forced the neglect of science upon public attention; but no estimate of the results of this neglect will ever be possible. It was deliberately decided that cotton was not required for the manufacture of nitro-cellulose, and might safely be admitted to Germany, and that lard also, not being capable of being used to make nitro-glycerine, need not be treated as contraband. Who can tell what this nescience entailed? Examples could be multiplied of grave decisions taken without adequate knowledge of facts and in defiance of the scientific spirit.

In July, 1916, a weighty letter was published in the *Times*, signed by thirty-six leaders of science who pointed out that:—

"Our success, now and in the difficult times of reorganization after the war, depends largely upon the possession of our leaders and administrators of scientific methods and the scientific habit of mind. They must have knowledge and the habit of promptly applying known means to known ends. To trust to luck is a mark of the dangerous complacency bred of ignorance."

This opinion, which few will dispute, was powerfully emphasized at a conference presided over by the late Lord Rayleigh in May, 1916. A strong Committee was afterwards formed, with Sir Ray Lancaster as Chairman, and Sir Richard Gregory as Hon. Secretary, which after a conference with the Council of Humanistic Studies, issued a valuable report. Sir Joseph Thomson's Committee followed with wide terms of reference. This Committee collected evidence of great importance, and its recommendations, if adopted, would go far to give to science a firm footing in the education of the future.

Meanwhile, Government was driven by the dire stress of the war to call science to its aid. Many committees, not always well selected, were set up to deal with the more pressing needs, and trained men of science were drawn from civil life as advisers and directors of research and manufacture. It is not too much to say that the admirable work thus accomplished saved a dangerous situation by supplying our gallant troops with essential requirements, but the pre-war neglect of science could not be wholly redeemed by improvization. In this hall last year, Sir Joseph Thomson quoted from one who was prominent in helping to apply science to military necessities. He wrote that it was a serious defect that in the General Staff at the War Office there was no officer "with any real knowledge of

science or appreciation of scientific questions." And he added these significant words:—" I hesitate to put down on paper what I believe to have been the cost of this complete ignorance among the General Staff; but it was at times appalling to me to contemplate."

As the result of the stern lessons of the war, we have set up much useful machinery for co-ordinating scientific progress, and for providing expert advice. Research has received a new impetus, both from Government and from industrial leaders. These are undoubted gains; but they will not suffice unless the application of what can best be described as the scientific spirit to the solution of national problems is secured, which is the main object of the British Science Guild. We believe that out objects can be attained only by radical changes in our system of education. In a striking address on " The Influence of Science on Education," delivered in 1854, Dr. Whewell summarized the conclusions of Plato, drawn from the study of geometry in his day, in the following words:—

" That there was a certain and solid truth; a knowledge which was not opinion; a science which was more than seeming; that man has powers by which such truth, such knowledge, such science may be acquired; that therefore it ought to be sought not in geometry alone, but in other subjects also."

The powers of man to acquire the knowledge which is " not opinion " have been demonstrated in realms of which Plato had only a dim idea. The applications of such knowledge have played an immense part in moulding the destinies of mankind; but science as a great national educative force has not yet won its rightful place, and Plato's quarrel with the Sophists continues to this day.

The British Science Guild holds that it is vital to ordered progress that trained specialists should wield adequate authority in the national councils, and that it is essential and possible to impart such a scientific trend to national education, from the bottom to the top, as will affect the psychology of all classes and help to remedy many patent evils. As Dean Inge has lately pointed out, real progress must be moral in its essence, and Professor Tyndall was right in believing that the study of physics might be " a moral influence." Everyone who has attained an insight into the methods of science must be conscious that his attitude towards questions of all kinds is thereby affected. What we call the scientific habit of thought is acquired by the recognition of eternal and inexorable laws, by the pursuit of truth for truth's sake, by insistence upon proved facts, by the use of accurate language, and by distrust of mere words and catch phrases. Science is the deadly enemy of credulity, which our national education has failed to control, and the political and social effects of which we see every day in exasperating forms.

There never was a time when it was so necessary to prove all things and to hold fast to that which is good. There never was a time when such determined efforts were made to create a perverted

psychology among the masses now entrusted with political power. Science has facilitated the operations of the propagandist, but has not yet succeeded in creating the mentality which would cause his effusions to be weighed in the balance. There are, I believe, many of our manual workers who are inclined to be distrustful of the mad theories impressed upon them and who are blindly seeking after truth. Might they not have been equipped by education so as to be enabled to form independent judgments and to examine the credentials of their self-constituted instructors?

Upon Parliament and the Departments of State will devolve increasingly heavy responsibilities. Here also a new mental attitude is sorely needed in order that the gifts of science may be brought to bear without stint upon the national welfare. We want in Parliament a group of members with sufficient knowledge to submit legislation and all public questions to the test of scientific examination as a corrective to the political and opportunist considerations which have led to grievous mistakes in the past.

In so far as there has been psychological perversion due to the causes which I have attempted to describe, the British Science Guild believes that remedies lie ready to our hands—remedies which it has earnestly striven to advocate in its fifteen years of existence, and which, as you will gather from the present Annual Report, it will continue to advocate in the future.

The horizon of the Empire is dark with heavy clouds. We are threatened with greater dangers than that of German militarism, which has been broken mainly by the spirit of the British race. The survival of civilization, already submerged in some parts of the world, turns upon the application of scientific knowledge to the national life. We can fulfil the vital requirements of our people only by complex organizations, the disintegration of which would mean suffering, starvation, and disease, because nature cruelly punishes the violation of her laws. If knowledge is power, as Bacon held, it follows, as Goethe said, that "There is no more dreadful sight than ignorance in action," and Plato, who anticipated Goethe by more than 2,000 years, pointed out that the spectacle is more dreadful in proportion to the capability and the energy of the ignorant agent. I firmly believe that upon the psychology of the British people the future of civilization must largely depend. We can, if we will, not only reconstruct our prosperity on broader and more stable foundations, but help to save the stricken and distracted peoples of Europe. Whether we rise, as an Empire, to the accomplishment of the mission which Providence holds out to us, or whether we go under like the great Empires of the past, will be determined by the moral qualities, which our race retains from the training of its long history, from the teaching of its greatest men, and from the shining example of its heroes on sea and land and in the air.

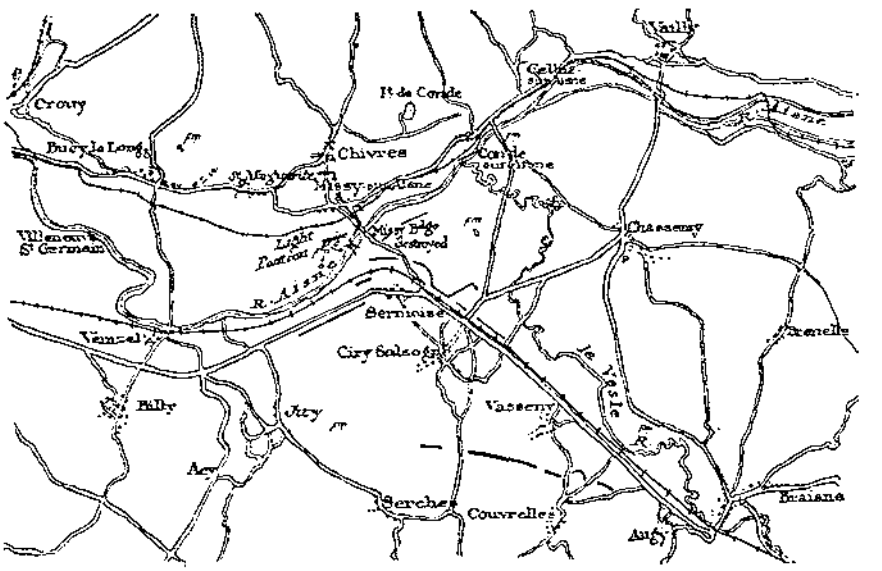
FROM THE AISNE TO YPRES, 1914.

FURTHER INCIDENTS IN THE STORY OF THE 59TH FIELD COMPANY, R.E.

By BRIG. GENERAL G. WALKER, D.S.O.

IN my last article, published in the *R.E. Journal* of April 1919, I carried my narrative down to the end of September 1914, but there is one more incident which occurred during the construction of the light infantry bridge at Missy which is worth recording. It happened to Johnston. Very strict orders had been given that there were to be no lights and no smoking. We officers had electric torches and Johnston lent his to a N.C.O. to examine some detail of the work. They got separated in the crush and not long after, Johnston, to his horror, saw a torch beam being flashed all over the place. He rushed up and incontinently knocked the offender, whom he did not recognise, into the river. After he had done so he enquired; "Who is it?" He was told it was the man to whom he had lent his torch. The unhappy victim as soon as he was fished out made most humble apologies to Johnston for dropping the torch in the stream, little knowing whom he had to thank for his ducking!

The military situation was now more or less as follows: (*Plan* I)—



PLAN I.

The 5th Division held the village of Missy on the North side of the river with one Brigade, their position being connected with the South side by the pontoon (" medium ") bridge at Venizel and the " light " pontoon bridge not far from the site of the broken-down road bridge at Missy itself. Our brigade (13th) prolonged the line eastwards along the south bank of the river to meet the 3rd Division which were in and about Vailly. The third brigade of the Division was I think in reserve somewhere between Sermoise and Serches. The 14th and 15th Brigades relieved each other in Missy.

Condé bridge was in front of the 13th Brigade and was in the hands of the Germans and no one I believe could get to it. We tried one night but with tragic results. This bridge was a source of constant anxiety and was watched by some of the North Irish Horse. It was this right section of the line that the 59th Company was concerned with. Our work consisted in assisting the infantry on the front line near the river (but not much help was asked for) and building a second line in front of Sermoise and Ciry Station with the aid of infantry working parties for whom we had great difficulty in getting tools. The line ran roughly parallel to the railway and sometimes actually along it where it lay in a cutting. Here we could work by day but most of the work had to be done at night. I remember that there was a good deal of doubt at one time in the minds of some people as to where this line ran. One night when I arrived with my men I found a stray Infantry working party extended for work at right angles to our trenches. I thought they had been sent without warning to help me and I suggested this to the Commander and also that he should extend along my line. However he said he knew nothing about me, that his Colonel had given him his job and that he must carry it out. The result was that we both dug that night at right angles to one another. Rather a waste of energy and indicative of a certain want of combination somewhere.

The details of the work were of the simplest, as parties and tools were very short, and the result was little more than the most rudimentary line of trench, to form the nucleus of something better later. We did I remember start some dug-outs in the railway cutting. Curiously enough, although the German aeroplanes must have known all about it, I do not remember our being shot at, though they did shoot at Ciry station and the farm behind it where we lived, the batteries south of the road and in the neighbourhood of Ciry village.

One peculiarity of this part of the country was that it contained a series of prehistoric cave dwellings. There were some near Ciry village but the most intricate and the largest existed on the high plateau above the village and about 1½ miles to the east of it. This

was a most extraordinary place, which had to be explored with lights. Chamber after chamber existed, some large and some small. It was supposed to be a harbour for spies and at one time was guarded, though I never heard of anyone being discovered there.

Besides the front lines along the river we were also engaged on a third retired line on top of the plateau. It came from near Serches towards Couvrelles on the flat ground on top and then dropped down into the low country to cover Couvrelles and ran between that place and Vassemy and then on east towards Braine.

We did a lot of work on the portion actually covering Couvrelles. It was a troublesome job, as the location of the line ran through a very thick wood and along very steep ground. There was a great deal of clearing to be done and the clearance of the timber was a great problem. The C.E. of the Corps I remember was much concerned about this part and often came to see us at work.

We were well hidden and worked all the time by day. The routine was roughly half a company here and half a company near the river on alternate days. Tools and materials were the difficulties as usual at this early stage of the war. We were much concerned about spies also at this period. We were warned of a motor car with head lights, that was said to run along the Braine-Sermoise road at night, the departure of which was supposed to be followed immediately by German shells. I was on the road at Ciry station one night and saw such a car approaching. I signalled it to stop but without effect, so as it came up to me at a good round pace; I drew my revolver and presented it at the driver. Such a scrunching of wheels and screeching of breaks as the car tried to stop in its track and then out of the back a figure scrambled and came up to me. I recognised him as the son of a very old friend of mine at home in Kildare, a young R.A.S.C. officer, who had been a cadet in the Sandhurst Company at Woolwich, when I was a teacher there in 1905. He was full of apologies needless to say—I told his mother about it long afterwards to her somewhat doubtful amusement.

Towards the end of September rumours of a move had been in the air, and a Field Ambulance, that had been quartered with us at Couvrelles and which had tried hard but ineffectually to evict us from the Chateau, had disappeared secretly one night when we were out at work. They never told us they were moving, (where they were going would not have interested us in the least) and when we got back from work in the morning we found that a lot of sponges, razors, &c. had disappeared. My kit had not been touched but all the

others had lost things. I wrote a polite note to the O.C. suggesting that perhaps the batmen in the dark and in the hurry of departure, had mistaken some of the rooms. I got a rather indignant reply, but no sponges or razors. I hope Heaven will forgive me if I did those batmen an injustice.

On the night of the 2nd October we left our comfortable billets in Couvrelles Chateau where we had passed a pleasant fortnight with the 12th Lancers and the Scots Greys of Sir Phillip Chetwode's brigade. Comfortable beds, good food, baths, and electric light (run by my servant) had been the order of the day and we were sorry to leave them. We had short notice of this move. The C.E. came to see us in the morning and asked if I had any orders and, when I said 'No,' he replied that I ought to know, as they were coming. Of course we started packing at once and I think, if we had not had this timely warning and had waited for the orders to come through the ordinary channel, we should never have got off to time. As it was we were all ready and moved to join 13th Brigade at 7 p.m. It is worthy of note that the bridging equipment which we lost at Mons, 5 weeks previously, was replaced at noon this day. This shows the difficulties we were labouring under owing to lack of stores.

I was much amused at two incidents that happened here. The first might have been a tragedy but the tragedy missed fire. We had returned to our billets from our work on the river, when, at about 3.30 a.m., our Adjutant, J. R. White, came in and woke me up telling me that the Germans had crossed the river in large numbers at Condé bridge and that we were to go up and man the second line trenches and hang on until the reserve Infantry Brigade relieved us We had dug these trenches and knew the ground well. We all turned out with rather mixed feelings and started. It was a lovely autumn morning, not a cloud in the sky, not a sound in the air and I could hardly believe that we were in for what would have been the scrap of our lives. However, we manned the line, served out ammunition and took such precautions as were possible, to enable us to get good warning of the hostile advance. We sat on the hills until near 8 a.m., and nothing happened and eventually got a message to withdraw, as the show was off. On our way back to bed we met the relieving troops of the 13th Infantry Brigade, who had marched miles to our rescue. Their feelings beggar description and we left them to ruminate on the result of the dreams of ghost-seeing subalterns. I believe the scare started on the report of a subaltern commanding a picquet on the river near Condé, but I have never been able to get at the rights of the case.

The other incident was less disconcerting. The Commander of the 13th Brigade came into the Chateau park one morning just after

the arrival of our first reinforcing draft, since we had left home. A good strong draft it was, made up of good, lusty, clean and well-fed men. We gave the Brigadier a general salute and he proceeded to inspect. When all was over he said to me that we were a wonderful Corps—"Just to think that those fellows have been all through the great retreat." I confess with shame that I did not reveal the real state of affairs. The men who had been through the mill deserved the eulogy too well. Enough of digression, however.

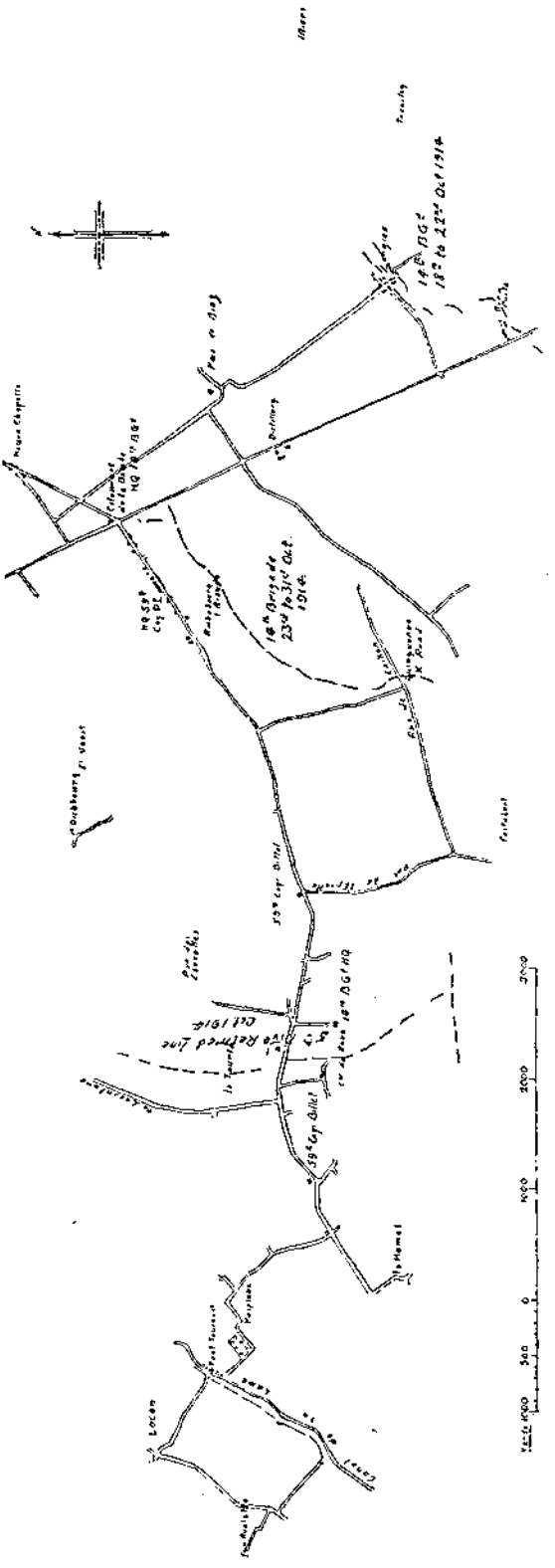
We left Couvrelles at nightfall on 2nd October, as stated before, and started to join the 13th Brigade en route for an unknown destination. We marched all that night to Violane where we spent the day. On the road again next night and so marched by night and slept by day until we arrived at Pont St. Maxence on 7th October. Our actual halting places were Longpont 4th, Buy 5th, Bethisey 6th. We entrained rather disjointedly on 7th—Headquarters & Nos. 2 & 4 Sections at Pont St. Maxence—No. 1 Section, Compiegne—No. 3 Section, Le Meux. It was not an unpleasant walk as the peasantry were most kind. At Buy, the old gentleman farmer on whom we were billeted, told me the Boche had taken all his horses, the French Army had his sons and he and his wife and daughters had to run the farm. At dinner that night he came in with a magnum of sweet champagne and asked if we would honour him by drinking it. I replied that we most certainly would, if he would join us, and down he sat. We had a very pleasant evening and no sore heads after. He was a charming old gentleman, in spite of his dirty threadbare clothes, and discoursed volubly upon the war in general and the iniquities of the Germans in particular. The march was without incident except for an occasional jamming of the troops on the road in the dark. I think it was during this trek that we had our first church parade at Longpont. There was no chaplain but, as it was the first Sunday since we started that we had not been actually in action, Johnston and I thought we would have a voluntary church. We were billeted in a chateau stable and we had our service under some cedar trees. A good few of the men turned up and I just read the morning prayers for them. We made this a regular practice from this on, whenever we had a quiet Sunday. I think the men were shy of it at first, but I believe they got to like it after a bit.

Pont St. Maxence presented but little of interest except the improvised floating barge bridge put up by the French alongside the stone bridge, which had been blown up by somebody during the retreat. It was here that we first began to realise that we were going north again. We had got in early in the morning and had a whole day to look about and pick up the news. We entrained at 7 p.m. and started off via Creil for Abbeville. We got to Creil about

8 p.m. As we sailed into the station I heard a dreadful hubbub on the platform and on getting out found that one of our horses had fallen down in the cattle truck and was lying on the floor with his fore legs hanging out. How the door got open is still a mystery. We had a troublesome job to get him on his legs again and back into the truck. General Sandbach, C.E. 2nd Corps, Flint and myself were the chief actors and when all was done the French station-master started the train, without giving Flint or myself a chance of getting back to our carriage. There we were, left behind, with the Company gaily going off to Heaven alone knew where. However, the General got the train stopped somehow, just outside the station, and we were able to rejoin it, so all was well. We reached Abbeville at 4 next morning, detrained and from thence began our march to Bethune (October 8th).

After breakfast and a wash we started on our march to the N.E. A good billet at Millencourt that night, rest next day and then on *via* Genne—Ivergney to Haravesnes where we got into busses and arrived at Rosemont near St. Pol (11th October). We got in about midnight and were off again at dawn with the advanced guard of the left, or northern, column of the 15th Brigade (it marched by 2 roads). It was an uneventful day, but a long march, and we could hear the French guns in action on our right. We did not actually go to Bethune, but to Hinges via Chocques, we arrived late in the afternoon—too late to do much.

We found the Germans on the canal at Avelette and our infantry in touch with them. However there was no action that night. The company billeted at Oblingham, No. 1 Section remaining with the advanced guard group. I think the Germans must have drawn off during the darkness as we crossed the canal quite peacefully next morning at Avelette (October 12th) and marched on through Locon and Merplaux to Le Touret on the road to Richebourg L'Avoué; a place that we were not to reach however for some time nor without a lot of fighting (*Plan* II). We got to Le Touret quite early this morning (October 12th) and there met the French Cavalry (Cuirassiers) whom we were to replace. There was a good deal of promiscuous scrapping going on and our infantry were feeling their way up towards Richebourg L'Avoué. We were with the 14th Brigade (Brig.-General Rolt) who met the French Officer Commanding the Cavalry at the Le Touret estaminet. There seemed to be a good deal of doubt as to where the French advanced posts really were. Their G.O.C., a fiery old Cavalry man, stated that they were in an almost impossible situation and this our Brigadier took leave to doubt. The old man was furious and said "If you don't believe me I will get a Regimental Commander to verify what I say." On the arrival of the Regimental Commander the latter gave the



PLAN II.—*Fighting round Richebourg l'Avoué, October, 1914.*

whole show away by saying that the posts were nowhere near as far ahead as was supposed. Tableau! Much vociferous talking among the French and we got on with the business in hand. I was much surprised to see these French "Tins" wearing their breast plates. The men's were dirty and rusty, but those of the officers were shining nickel or silver plate, and this was modern war.

We now commenced a furious struggle to surround and take La Bassée. The 13th and 15th Brigades went for it direct through Givenchy and Festubert while we, with the 14th, "fetched a compass" via Richebourg and Lorgie. The 5th Divisional Headquarters was at Gorre Chateau. It was slow work in the flat blind country. The weather was fine but the land was so flat that we could seldom get a view. There was little engineering work. The sections of the company were detailed to work with the four battalions of the Brigade while the Headquarters remained with Brigade Headquarters. The work of the sections amounted to little more than improving and strengthening positions taken and improving communications.

On the 13th the Company Headquarters were moved back to Locon to reconnoitre a site for a pontoon bridge and we billeted there that night but we were all reunited again next day at Le Touret (14th).

The Germans delivered a very heavy attack about 6 p.m. on the evening of the 14th and no work could be done. We lost Pennycuick wounded this evening—our first officer casualty. He was a great loss to us and had already won a D.S.O. So we moved on north-eastwards, pretty slowly and the Brigade made good Richebourg L'Avoué on the 17th October and we took up our quarters there that night in a comfortable house in the main street. The advance had been pretty slow—5 days doing 8 miles. However, we were going ahead which was the great thing. About this time I had an amusing experience. I was standing on the road near Le Touret talking to the O.C. of the Field Ambulance billeted next door to us when a car containing a smartly dressed individual drove up and stopped. I recognised the occupant as a civilian of my acquaintance. On being asked what he was doing he replied that he was making enquiries as to the treatment of the wounded by our doctors, as there had been some complaints about it. He was not a doctor himself, and I thought it rather tactless of him to broach the subject so boldly in the actual presence of a senior officer of the R.A.M.C. I told him that I had no complaints from my own men but that, if he wanted first hand information, I would take him up to where people were getting wounded and he could look into things for himself. He thanked me profusely and said he had an appointment in quite the opposite direction and left us, much to the

amusement of my doctor friend. I never heard any more of him or his mission.

The R.E. got into Lorgie on the night of the 18th and we started strengthening the place and positions in the neighbourhood. The General idea of the defences is shown in *Plan* No. II.

Our direction had now changed nearly south and we were within 2 miles of La Bassée. Antwerp had fallen but we still lived in hope. The general situation was—5th Division on a line from the La Bassée canal through Givenchy—Festubert—Violanes—Beau Puits—Lorgie —3rd Division from thence through Illies and Herlies. The greatest pressure from the Germans seemed to be on the left, though we all had plenty of excitement. Poor Carr got a shrapnel burst all over him in the village street of Lorgie on the 20th. He had asked me for leave to go up, in daylight, and see something that his section was to do that night, and I let him go with much misgiving—— as he did not return I took the section up myself and found him in the dressing station. He was knocked about a lot but not badly wounded. He left that night for the base. We never saw him again as, when he recovered, he returned to France with the 27th Division R.E. and was killed near St. Eloi in February 1915. Poor fellow, he had joined us straight from Chatham in August, knowing nothing but what he had learnt from books. He made good wonderfully quickly and, like every good officer, soon gained the confidence of his men.

Our work at Lorgie consisted in entrenching the line from Beau Puits, which was in the 13th Brigade area through Lorgie towards Dalluiq. We had some advanced trenches down in the valley below Lorgie towards Le Transloy. The Germans were very active in and about Le Transloy. We called them trenches in those days but little more than a 3′ × 3′ trench suitably traversed could be made. There were no materials for revetments, no wire, no R.E. stores, and no parks to draw them from. Tools also were very scarce— we could get nothing except what we requisitioned on the ground. It was a great handicap to our work and one can only trust that things will be better next time. The R.E., although in the front line every night, did not suffer heavily; they were dog-tired but were well fed and housed near Brigade Headquarters which was at the "Estaminet de la Bombe"; afterwards I think called Port Arthur. Luckily the weather was pretty fair.

At Lorgie I saw one of the hottest fire fights that I have ever been in. I was passing through the village one night on my way from the right to the left of the line and was talking to a Battalion Commander at his H.Q. when the storm broke. Every gun and rifle in the country seemed to be going, both British and German. We took shelter behind a house to see what would happen and in

about 20 minutes the whole thing was over. Flint told me it stopped he thought by the men going to sleep over their rifles. There was no attack and no movement of any sort. When I got to Flint's section I found they had been shooting also and had lost 2 men killed. On my way to them not a shot came up and I walked along the ground at the back of the fire trench in the full glare of a burning rick without anything being thrown at me. The men in the trench seemed dead asleep and quite uninterested.

We had no shelters and no communication trenches and the men just lay huddled in the fire trench. The army was very tired, worn out almost, but their tails were well up. The R.E. were better off than most, as the orders were that they were to withdraw at dawn, so they got a quiet day with good food and sleep. They marched about 3 miles to and from their work, however, daily and were on their legs from about 4 p.m. until 6 or 7 next morning. However, it seemed to suit them, as they were always fit, there was no sickness, and they were always cheerful.

Our stay on the Lorgie line was not a long one. The pressure on the left of the 3rd Division, on our left, soon told, and on the 22nd October the blow fell. It was a terribly mixed-up affair. We had been with the D.C.L.I. below Lorgie until daylight and had moved back just before the attack. The D.C.L.I. were badly mauled and lost a lot and I believe the 3rd Division lost a whole battalion prisoners about the same time. We got back to our billets about 7 a.m. and at 11 I was told to be ready to complete the reserve trenches, which had been already commenced by civil labour, between Estaminet de la Bombe and Quinquerue cross roads on the Rue du Caillou, by dawn next morning. The length of line was about 3,000 yards. I had never seen it and did not know what the civilians had done.

Johnston and I spent the morning with the C.R.E.'s Adjutant going over the place and making up our minds what to do. We had the company at work by 2 p.m. Each section on a bit, to try and make the line for the Infantry to hold that night. I have forgotten how many men we had in the company then but there was no one else and I imagine it worked out to about a man to every 30 yards, including trenching and wiring. However, we got at the worst places and went ahead.

Later on I was told that I must guide the troops to their positions as they came in, anytime after midnight. I said that I would show them into the pews that I had dug, but that the C.R.E. must see them into those that he had provided. We worked on without pause until the troops arrived about 5 a.m. (23rd October). I shall never forget the pew opening ceremony. Every Colonel told me I was a lunatic to think that his battalion could hold so long a bit and there

were many other remarks. However, I said "G.O.C.'s orders," which was a lie, as the orders were my own. However, we got them all settled in eventually. Meanwhile the work went on until daylight and then we broke off. Our men had worked about 14 hours on end and some of them were staggering with fatigue. However, they were all cheerful and marched off to their old billets at Le Touret. The Germans did not appear until 10 a.m. and then did nothing much. Our infantry held and improved those trenches until withdrawn on the 30th Oct. God knows how they did it. They were weak in body and in numbers but they must have fought by some special inspiration. There were practically no reserves. One night I know we had only 2 companies on our side. The Brigadier's Headquarters was now at Du Raux farm. He and his staff must have had a most anxious time. We were not so badly off, as we had no time to think and saw what was going on in front every night.

While the 14th Brigade was holding Lorgie we were billeted in Richebourg L'Avoué but when the Brigade withdrew to the line Quinquerue cross roads—Estaminet de la Bombe—we went back to our old billet in a farm near Le Touret. Our work consisted entirely in helping the infantry to improve their new trenches and assisting in the execution of the Divisional second line from Lacouture on the left and passing just in front of Le Touret towards where Rue de l'Epinette joined Rue de Caillou.

The work on the front line was of the most elementary description owing to lack of men and materials. We used barbed wire from fences and timber from local wheelers' shops and so on. One day long afterwards in Salonika I received an enquiry, from the Compensations Commission in France, asking for particulars. The questions were as follows:—Had I really had the material I signed for, had I really used it and what for, had I ever recovered any of it and returned it to the owners, and finally, could I remember what was the distance apart "*in inches*" of the barbs on the wire? I always knew that financial mills ground very closely but I never realised how closely until then. I forget what my answer was but I doubt if it was polite. Yes—we learned then, by bitter experience, how bad our store organisation was.

The infantry did a lot of work now and the trenches improved fairly rapidly but there were no communications and one could not get into the trenches except in the dark. Johnston and I had a nerve racking experience about this time (28th Oct.) we were told to site a switch from Richebourg L'Avoué behind Neuve Chapelle to join up with the 3rd Division on the La Bassée Chaussée, North-west of Neuve Chapelle. We got out at daylight and found everything quite peaceful. We wandered about with our map, when

suddenly 3 field gun shells burst, one in front of me, one behind Johnston and one between us but slightly to our right, (we were walking about 20 yards apart). Needless to say we were in the bottom of a deep ditch in less time than this takes to write and then 6 more rounds came up to look for us. Where the fire came from Heaven knows, but it was a sporting, and very nearly a successful, effort on the part of the German gunners.

(To be continued).

Entraining, Havre, 20th Aug., 1914.

On the march during the retreat.

A halt on the march to the Marne.

The river Aisne, near Missy, looking south towards Sermoise.

FROM THE AISNE TO YPRES. 1914.

AISNE TO YPRES 1914

THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

In September, 1919, *The Royal Engineers Journal* published an introductory notice and proposed synopsis of the official records of "The Work of the Royal Engineers in the European War, 1914–1919," which were in course of preparation for publication, and since that date portions of these records have appeared in every number of the *Journal*.

It has now been decided that the more important of these records shall be published by the R.E. Institute in book form. Only a very limited number of copies will be printed, and these volumes will be sold to members of the R.E. Institute at prices, ranging probably between five and ten shillings, which will be about half the prices which will be charged to the general public.

The publication of the following volumes is being taken in hand at once :—

Work under the Engineer-in-Chief, B.E.F.		Water supply.
do.	do.	Mining : Historical and Mine Rescue Work.
do.	do.	Mining : Technical.
do.	do.	Bridging.
do.	do.	Camouflage, Workshops, Machinery, and Electricity.
do.	do.	Geology.
do.	do.	Experimental Section.
Work under the Director of Works (France).		
do.	do.	Plates only.
Egypt and Palestine Water Supply.		

The Secretary, R.E. Institute, Chatham, would be glad to receive the names of members who wish to reserve the right to purchase the various volumes as they appear. (A form of notification is enclosed).

It is not at present contemplated to publish the whole of the records in book form, and some of the shorter reports will continue to appear from time to time in *The R.E. Journal*.

CORRESPONDENCE.

ORGANIZATION AND EMPLOYMENT OF ENGINEERS IN WAR.

To the Editor of the R.E. JOURNAL.

SIR,—With reference to the article "Organization and Employment of Engineers in War," which appeared in the May number of the *R.E. Journal*, I am not in favour of the organization of the Divisional R.E. into three double companies for the following reasons :—

(*a*) The three double companies would absorb an undue number of officers in their three headquarters.

(*b*) That organization approximates to a three-battalion organization of two companies each, which I do not consider advisable for the reasons adduced in paragraph 15 of the article in question.

2. I would suggest instead, four companies, each of approximate strength of 350 (Sections, 70 strong), and a headquarter company, chiefly skilled tradesmen, approximate strength 120.

C.R.E. to have the same rank as an Infantry Brigadier and to have a Brigade Major (substantive Major), Staff Captain and, if considered necessary, a Stores Officer working under and assisting the latter.

Establishment of officers for each of the four Field Companies to be :—

1 Major Commanding.
1 Senior Captain (G), 2nd in Command and for operations and liaison work with the Infantry Brigade, etc.
1 Captain, duties as at present performed (A and Q), (A and Q work, Stores, etc.).
6 Subalterns : 1 per section, 1 to assist Captain (A and Q) or replace casualties (5th Sub.), 1 spare to replace casualties, leave, etc. (6th Sub.)

3. This organization permits of a force of 2 Sections under a suitable Commanding Officer (the Senior Captain), being detached, if required, to strengthen the working party in another sector or to carry out work for units other than infantry, *e.g.*, R.A. or R.A.M.C. The 5th Subaltern would normally accompany this force.

Establishments of officers for the Headquarter Company to be :—

1 Captain,
3 Subalterns (1 spare for casualties, leave, etc.).

4. The advantages of the four-company organization appear to me to be as follows :—

(*a*) It preserves the individuality of the company as a unit and is a more satisfactory command from a Company Commander's point of view.

(*b*) It is at least as flexible an organization as the double-company one, as it can if necessary be split up into eight units—each of greater strength than one section, suitably commanded and administered.

(*c*) It requires a smaller establishment of officers for approximately the same total strength.

(*d*) In position warfare when the line is held as a two-brigade point, up to two companies can, if required, be allotted to each sector. When the line is held as a three-brigade front, one company can be allocated to each sector, and one company held as C.R.E.'s reserve, or for communications, etc.

(*e*) In open warfare one company can be allotted to each Brigade, and one company, together with the Headquarter Company, kept as C.R.E.'s Reserve.

5. As late O.C. 5th Field Co., R.E., and C.R.E. of the 23rd Division with experience in both position warfare (in France, Flanders, and Italy), and in open warfare (in Italy), I would personally prefer to have my command organized as outlined above rather than organized on the double-company system.

Yours, etc.,

E. H. ROOKE, *Lieut.-Colonel,*
C.R.E., West Africa.

REVIEWS.

CEMENT.—MONOGRAPHS ON INDUSTRIAL CHEMISTRY.

By BERTRAM BLOUNT.

This book is written more for the benefit of the cement manufacturer than for the concrete engineer. For the former it contains much useful information regarding old and new methods of manufacture, detailed descriptions of the best methods of testing and latest types of machinery, and valuable suggestions for works management and works economics. To the latter the book is chiefly of historical and scientific interest. The chapter on the " Effects of various substances on Cement " is informing and of interest to all users of cement and concrete.

J. C. P. T.

TELEPHONIC TRANSMISSION.

By J. G. HILL. (Longmans, Green & Co.). Price 5/6.

This book is one of the "Manuals of Telegraph and Telephone Engineering," edited by Sir William Slingo, late Engineer-in-Chief to the G.P.O. The first part deals with the calculation of direct and alternating currents in lines with resistance, leakage, inductance, and capacity, and discusses in detail the questions of phase, power, and reflection. Loading is then dealt with, from the theoretical and practical points of view. Practical applications are considered, including cost problems, phantoms, and repeaters, the general object being to provide data for, and methods of, dealing with problems, suitable for use by engineers and designers of telephone systems who have to construct the cheapest system of communication consistent with efficiency. The standard of mathematics necessary to follow the discussions includes knowledge of elementary calculus, the relations between trigonometrical and exponential functions and a slight acquaintance with hyperbolic functions, which are extensively used. A mathematical introduction contains many useful formulæ and proofs, and an introduction to hyperbolic functions. The general treatment is on the whole clear, but some criticism may be made. There are many unnecessary cross references which could easily be dispensed with. Diagrams, of which there are many that are very useful, have in some cases insufficient explanation on the same page. The number and frequency of examples might be increased with profit, but those given are practical and practically worked out. The symbols used are consistent, but letter suffixes, as used by Dr. Kennelly, seem preferable to figure suffixes, as being more explanatory and less liable to confusion. The book contains data and methods for the solution of most problems that are likely to be met with, but it is not arranged in a manner likely to help a reader to find quickly the data and methods required for the solution of a particular problem. Altogether one gets a very good idea of the problems that have to be faced by a permanent-line engineer and how they are met in practice, including very modern work, such as the development of repeaters, which are very well dealt with in the last chapter. Special features of this work are the numerous curves and tables, frequency of reference to original papers, and the close attention to cost consideration. The book should be very useful to permanent-line engineers, but in the Army it would probably be of use only to specialists with units constructing long permanent and airline routes, when loading or the use of repeaters might be resorted to. In this case it would give the information required to obtain the best results. The only errors and misprints noticed are:—Page 37, "A transmitting current of any length"; page 166, Fig. 2 should read Fig. 87; page 166, "the diameter of the wire may be taken as 171 miles."

R. H. NISBET, *Lieut., R.E.*

NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

No. 92.—*The Economic Consequences of the Peace*, by J. M. Keynes, receives a prominent notice and evidently raises hopes of a revision of the peace treaty. A writer complains that the state of affairs in Germany is rapidly approaching that in Russia; prices are soaring, the fixed salary classes are starving and trade can only be done by barter, while the printing presses are working overtime turning out valueless bank notes.

Official Notices.—So many fraudulent transactions are taking place in connection with the exchange of Bermondt notes that in future cashiers will only change up to 300 marks for individuals who can prove they formed part of the Baltic troops.

No. 93.—*Courts of Honour.*—Lieut.-General von Altrock advocates the re-establishment of the officers courts-of-honour which existed before the revolution. Provision has been made in the regulations governing the new army for tribunals very similar to the old courts but somewhat limited in scope and power. Von Altrock regrets this and advocates the formation of courts on pre-war lines by every officers' union. This craving for definition by some superior authority of what is proper and what is not is very characteristic of the German. How is he to know how to behave if nobody tells him?

The Riddle of the Marne is another article on one of the many books now appearing dealing with this subject. This one, by General von Hausen, describes the action of the Third Army and blames von Bulow's (2nd) Army for the holding up of the German offensive. Von Bulow, as has already been seen, is quite prepared to take the responsibility for his action.

The *M.W.B.* now publishes in each number an appeal to all who wish to stand for really unprejudiced and impartial writing on the war to increase the circulation of the *M.W.B.* "Our children must not learn from enemy sources."

Roll of Honour.—Jager Battalion No. 8.—51 officers and 1,422 other ranks.

No. 94.—*Memories by Lord Fisher* is reviewed at length and with much satisfaction, as proving once for all that England willed the war from the very first, that Germany carried it on successfully right up to the Armistice and that even then the German Army was only defeated by a stab in the back from its own people.

Roumania and Soviet Russia.—The writer comments on the many contradictory rumours current regarding the probable course of events between Russia and Poland and concludes that, whatever happens, an offensive by Poland against Russia cannot be undertaken. (This appears on the 28th February and recent events have, so far proved the writer a false prophet. It is to be hoped that he is equally wrong in his estimate

of conditions in Roumania). He declares that Bolshevism has so permeated the Roumanian Army that, far from being in a position to attack Russia, it could hardly defend itself and that it remains to be seen if Soviet Russia will renounce the certain victory that awaits her if she cares to take the offensive in that direction.

Roll of Honour.—Infantry Regiment No. 61.—91 officers and 3,677 other ranks.

No. 95.—*Technique in the War* is an apparently monumental work edited by General von Schwarte. Its reviewer remarks on the lack of recognition which the subject received before the war. He says that general staff officers were rewarded for good work by accelerated promotion but that heavy artillery and pioneer officers got but little recompense. Since the war, however, every prominent writer has felt compelled to recognize them and this book will provide a record of the great work they accomplished.

Swedish Opinion on the Versailles Treaty.—The *M.W.B.* is delighted to find that a Swedish writer holds correct views regarding the treaty, and describes it in the best German manner. He gives still greater satisfaction by declaring that the next generation of Germans will throw off their chains, and then the world will learn what *vae victis* really means.

The Military Political Situation—This article repeats the often-expressed opinions regarding Anglo-Russian and Franco-Polish relations. The hatred of Poland is a very marked feature of present day German feeling. The surrender of war criminals still receives much attention and the writer is glad to find that Germany, in resisting this, retains a particle of that national honour which she so cowardly surrendered in November, 1918. He suggests that the German Government should now forward its list of those who, on the Allies' side, have been guilty of war crimes and demand their trial. Material for such a list is, he says, all ready and based on unprejudiced sworn evidence, but the absurd irresponsible accusations made by the Allies need not be considered.

Sport in the Army.—The new German Army is to go in for sports in a very thorough manner and text books for its guidance are being drafted. Every man is to have his sports kit and every station to be provided with the necessary grounds. Instructors will be appointed and rules drafted for competitions both inter-unit and with civilian clubs.

No. 96.—*Battles and Combats of the Great War, 1914—1918* is the title of the final publication by the General Staff, *prior* to its abolition. Judging from the reviewers' account of the book it appears likely to constitute a very useful work of reference for future historians.

German Mission to Austria.—Lieut.-General von Kramo publishes his story of his work as chief of the German Mission to Austria. He exposes the intrigues of the Austro-Hungarian court and describes how on the death of Franz-Joseph, the new Emperor fell under the influence of the pacifists to such an extent that eventually no reliance could be placed on him.

Settlement of ex-Soldiers.—The question of the settlement of ex-soldiers on the land is again discussed. The writer urges the use of the old

Army training areas for this purpose; as these were naturally chosen largely because of their worthlessness for other purposes, the unfortunate ex-soldiers will not benefit much from them; such areas as Paderborn and Elsenborn being about as valuable, agriculturally, as the Long Valley at Aldershot.

Cavalry Equipment.—It has been decided that the new Army Cavalry shall carry lance, carbine and short side arm. The sword is, provisionally, abolished.

The Two White Nations, by Capt. von Hase, of the German Navy, begins with pre-war reminiscences of the good feeling between English and German ships. The title is from a toast alleged to have been given by a British Admiral to his German colleague at an international "demonstration" in the Mediterranean. Capt. Hase, who was gunnery lieutenant on the *Derfflinger* at Jutland, declares that, had Lord Jellicoe pressed for a decision on that occasion, the British fleet would subsequently have had to yield its mastery of the seas to America. He also states that the fight, even if it did not bring final victory, had a splendid moral effect on the German Navy and nation.

No. 97.—*The Maintenance of Tradition in the New Army*—The writer emphasizes the importance of this and also the difficulties attending it. According to his estimate an infantry regiment in the new army will not as a rule have more than four pre-war officers and often fewer. In the other arms things will be even worse. The situation as regards non-commissioned officers is much the same. He concludes that the company will therefore be too small a unit to have any corporate spirit, but that the battalion will be the heir to the traditions of the units of the old army which are represented in it, and recommends that the Ministry of Defence lay down the lines on which this is to be effected.

The Legend of the Illegality of the Submarine War.—Captain Gadow, after patting himself on the back over the upshot of the controversy regarding the surrender of war criminals, discusses the legality of unrestricted submarine war by comparing it to the blockade by the British fleet and reaches the usual German conclusion. He remarks that whereas the U boats caused the loss of 14,661 British lives, the hunger blockade raised the death rate in Germany to such an extent that the German loss amounted to no less than 763,000, without reckoning decline in birth rate and after effects.

It is announced that berths in sleeping cars can be used at certain Berlin railway stations at 15 marks a night.

This number of the *M.W.B.*, which is dated 10th March, is the last which has come to hand. On the 12th Dr. Kapp and General Luttwitz started their singularly unsuccessful *Putsch* and it may be that the *Militär Wochenblatt*, though it has certainly given no overt sign of complicity with the revolution, has been considered too sympathetic with the reactionaries for its publication to be tolerated any longer. For an excellent account of the latest revolution the June number of *Blackwood* is recommended.

L. CHENEVIX-TRENCH, *Major, R.E.*

REVUE MILITAIRE GÉNÉRALE.

January. 1920.

Army reconnaissance in the single seated aeroplane.—By Capt. P. Weiss. An argument in favour of using the light, swift, single seated aeroplane for gathering intelligence for the army command. When it is not a question of obtaining accurate photographs for the guidance of the troops in the front line, for which the heavier two-seater is more suitable, but of gleaning information and reporting rapidly on movements in the enemy's rear, such as concentration of troops or material, or movements of troops from one sector to another, the small swift machine is most useful. Owing to its lightness it can remain over one spot until the pilot has absorbed accurate details of all he sees and what it implies, and owing to its speed it is fairly safe from attack from the ground and can descend to verify details not fully comprehended from above, or screened by clouds. The pilot, since he is also observer must receive special training. His reports are verbal, and if he is not certain on any point the qualities of the machine enable a fresh journey to be quickly completed.

GERMAN OPINIONS OF THE WAR.

Deductions from the World War (continued).—Reasons are given to explain why the Germans did not anticipate much bayonet fighting. The war has re-introduced hand grenades and mining, and has given birth to flame throwers, bomb throwers, trench mortars of an improved pattern, the increased use of machine gun, gas warfare, and tanks. The use of indirect high angle fire by the artillery has been much extended, and it was found impossible adequately to supply ammunition. It is possible that for the future trenches strengthened by barbed wire screens will replace fortresses, except perhaps in situations where defensive tactics alone can be employed. Large towns will certainly not be fortified, but certain frontiers may have to be defended by a succession of permanent forts, connected by other works to be erected on the declaration of war. Attack is still the best defence, but "the war has disclosed the immense strength of a defence based on well-constructed fortifications, on account of the efficacy of modern weapons, and this revelation, taking into consideration our central geographical position, is of great value."

IV. Leadership.—In the case of leadership the intellectual element is important. The lessons of earlier wars must be applied with due consideration of their applicability to present conditions. The corps of 1866 and 1870 has now attained the dimensions of the army of those days, and the difference between the warlike appliances of 1870 and those of the Napoleonic wars was less great than now exists between our modern appliances and those of 1870. Peace exercises give no conception of the effect of firearms at the commencement of a campaign. Again the improvement in firearms has resulted in a wide extension of the battle-front. Armies of the strength of those employed at Koniggratz now occupy four times the space. Field Marshal von Schlieffen realized these

points, and our successes in the war are due in great measure to his efforts in training the General Staff to a war of masses. Up to the Marne our exploits were brilliant, then the wastage of war made itself felt. Moltke's forces were at the beginning of the war of 1870 to the French forces in the proportion of 5 to 3. In 1914 the German forces on the French front were slightly less than the French alone, and counting the Belgian and British forces the deficiency was 750,000 men. Our intention had been to envelop both flanks, the envelopment of the French right was checked by their frontier defences, that of their left by a menace to our own right. The French were acting on interior lines, and their admirable system of railways and roads enabled them to reinforce their front quickly. If they had utilized these to the utmost after the battle of the Marne they might, by attacking our right flank, have prevented the establishment of our position on the Aisne.

A. R. Reynolds.

REVUE MILITAIRE SUISSE.

No. 2.—March, 1920.

The Evolution of the Battle of the Marne.

The original article is by Colonel Poudret, who points out that critics of Marshal Joffre continue to make themselves heard. Work upon work is being issued from the press, some written in a tone of moderation —as for example General Le Gros's *Genèse de la bataille de la Marne*— others in a spirit of excessive violence; the latter savour of the opening speech of a prosecutor and contain serious indictments against the French Higher Command, which is alleged to have been responsible for the incompleteness of the system of fortifications existing in France at the outbreak of the late War; the faulty initial concentration; the premature offensive operations in the early stages of the War; the precipitate abandonment of territory after the battles on and near the frontiers; lastly, an attempt is in some cases made to prove that the credit for the stand made on the Marne which has been generally attributed to Marshal Joffre has been so attributed erroneously and that the credit really belongs to others, particularly to General Gallieni, the Governor of Paris. Colonel Poudret points out that in the criticisms which have been levelled against the French Higher Command allowance is not always made for the fact that decisions had necessarily often to be taken on the meagre information at hand at the time the particular problem was under consideration; it was inevitable that in certain cases orders had to be issued and action taken on incomplete and even uncertain information. Colonel Poudret sets out the case made in favour of General Gallieni by those who advocate his cause and also that made on behalf of Marshal Joffre by the latter's partisans; he also touches upon some of the more important points in relation to this matter dealt with by General Le Gros in his recent work. He is of opinion that in spite of faults in the conduct of the initial stages

the campaign on the Western Front attributed to "père Joffre," the French generalissimo of 1914 stands out for all time as one of the veritable Grand Men of War.

THE RÔLE OF ENGINEER TROOPS IN THE WORLD WAR.

The original article is from the pen of Colonel Lecomte, who points out that it would be premature to attempt to deduce, from the incomplete information available at the present day, a complete theory of modern war under the latest conditions developed in the recent great conflict of arms. In the late struggle science and industry came handsomely to the aid of the fighting man and put all their resources at his disposal in the most complete manner possible. An immense wealth of technical appliances, etc., were placed at the disposal of the military engineer during the progress of the war. Engineer troops had thus an opportunity of performing a great variety of services, and taking advantage of it, played a most important rôle in the Great War. Many novel and special spheres of activity had to be assigned to the engineer troops in every one of the belligerent armies throughout the whole duration of the war; they did what was necessary in each case to develop these novel and special services up to the pitch of practicability. Having been brought into effective working order by the engineers, the new services were, in many cases, transferred into other hands for practical application, whilst the engineers turned their attention to yet further new fields of technical development. Colonel Lecomte classifies the duties undertaken by Engineers in the late War as follows:— 1. Construction and destruction of communications. 2. Entrenchment of the field of battle. 3. Laying out of encampments and cantonments and services in connection therewith. 4. Co-operation with the other arms in the actual fighting.

The duties as arranged above are in their relative order of importance according to the conception of Lecomte, who gives the reasons which have led him to adopt the foregoing classification and to assign to each group its position in the list. An extract is given in the original article from the instructions issued to the French Army in 1917 regarding the functions of engineer troops in the combat; the rôle of these troops in a modern war is also succinctly described. (*To be continued*).

ERICH LUDENDORFF.

The original article is contributed by Colonel Feyler; he very briefly traces the psychological evolution in Napoleon in relation to his outlook on military problems as a Commander-in-Chief; the Great Captain of cool calculation, he tells us, by reason of a too absorbing ambition, intensified by sustained success in war, developed, in time into an inveterate gambler ready to accept every risk, however hazardous.

Readers of the Memoirs of General Ludendorff as they ponder over the events, from the capture of Liége in August, 1914 to the armistice of November 11, 1918, in the career of Hindenburg's Quartermaster-General are from time to time reminded to some extent of the Great

Corsican's career; not that these two personages are, as Colonel Feyler points out, in any way comparable from the military point of view. Three essential qualities, says Colonel Feyler, were wanting in Ludendorff. If he had the power of cool calculation, he does not seem to have possessed any imagination. If he knew the German soldier, he does not seem to have understood men. If he possessed a competent knowledge of the science of strategy, he does seem to have been acquainted with the art of war. He has not that spark of genius which reanimates science by practical application of its principles, nor does he seem capable of keeping the torch of progressive knowledge burning through trying vicissitudes by the creative action possessed by those of great personality. Colonel Feyler shows that the foregoing shortcomings narrowed Ludendorff's outlook on the problems with which he had to deal and were largely responsible for his failure to appreciate in their true perspective the various elements that entered into combination, a failure which led eventually to the defeat of the German hosts.

Notes and News.

France.—A special correspondent refers to the debate in the French Parliament in relation to the calling up of the recruits of the 1920 class. The questions which have created most interest in relation to Army matters were those connected with the duration of the period for which the recruits should be called up and that of the period for which they should remain with the colours. It is generally accepted that three years is too long a period nowadays to withdraw youths from civil life for the purposes of a preliminary military training; there are some who argue that 8 months would suffice in which to train recruits, but the French General Staff is of opinion that recruits should be called to the colours, in the first instance, for one year. This question has been remitted to a Committee, under the presidency of General Castlenau, for investigation and report. The opinion seems to be widely held that Germany is already making active preparations for a War of Revenge and that for this reason no precautionary measures should be neglected which tend to checkmate German designs in an incipient stage.

Bibliography.

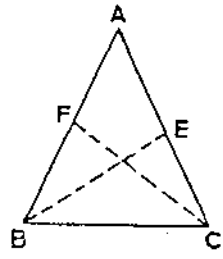
Notices are published relating to General Percin's 1914 *Les erreurs du haut commandement*; Viri's *Nation Armée*; Choisy's *La question balkanique devant l'opinion suisse*; and Puaux's *La Grèce*.

W. A. J. O'Meara.

PROBLEMS.

PROBLEM 9 (Proposed by Lieut. R. H. Nisbet).

A triangle ABC is such that the lengths of the bisectors BE, CF of the angles ABC and ACB are equal. Prove that AB=AC.



PROBLEM 10 (Proposed by Lieut.-Colonel J. M. Wade).

A corkscrew is held with its axis at right angles to a horizontal table, under what circumstances is the shadow of the screw, thrown by the sun on the table a cycloid?

Problems 1 to 8 have appeared in the recent issues of "The Supplement to the R.E. Journal."

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THIS Journal, which was formerly known as the "Proceedings" of the R.A. Institution, contains articles and information on Artillery matters, some highly technical and some general. Articles on general Military topics also appear.

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